

FIG. 1A

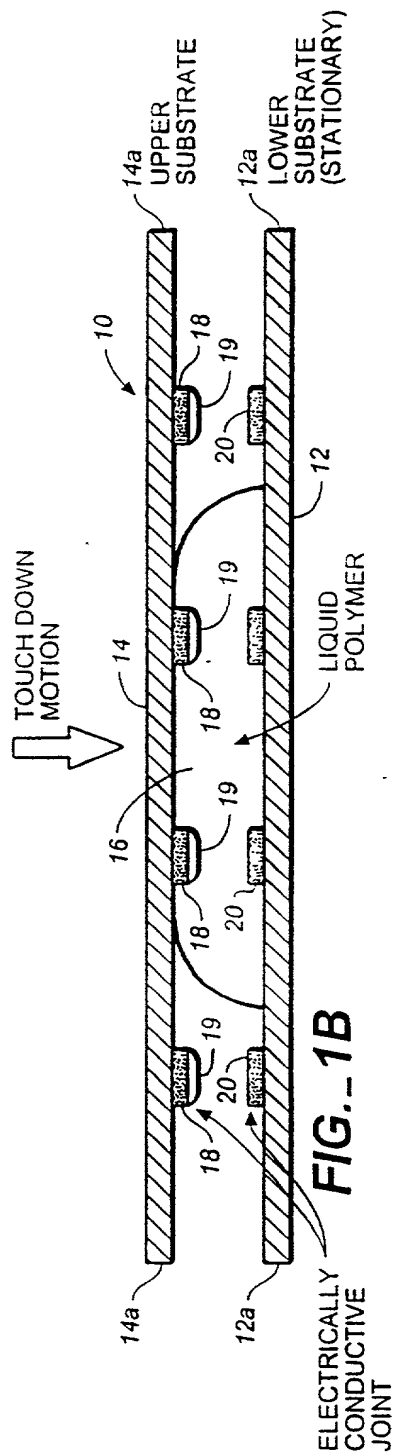


FIG. 1B

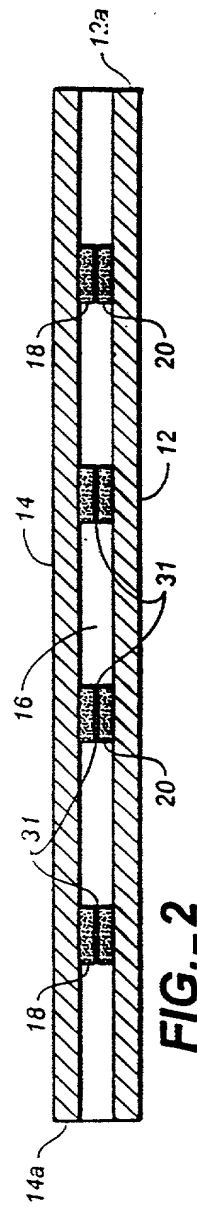


FIG. 2

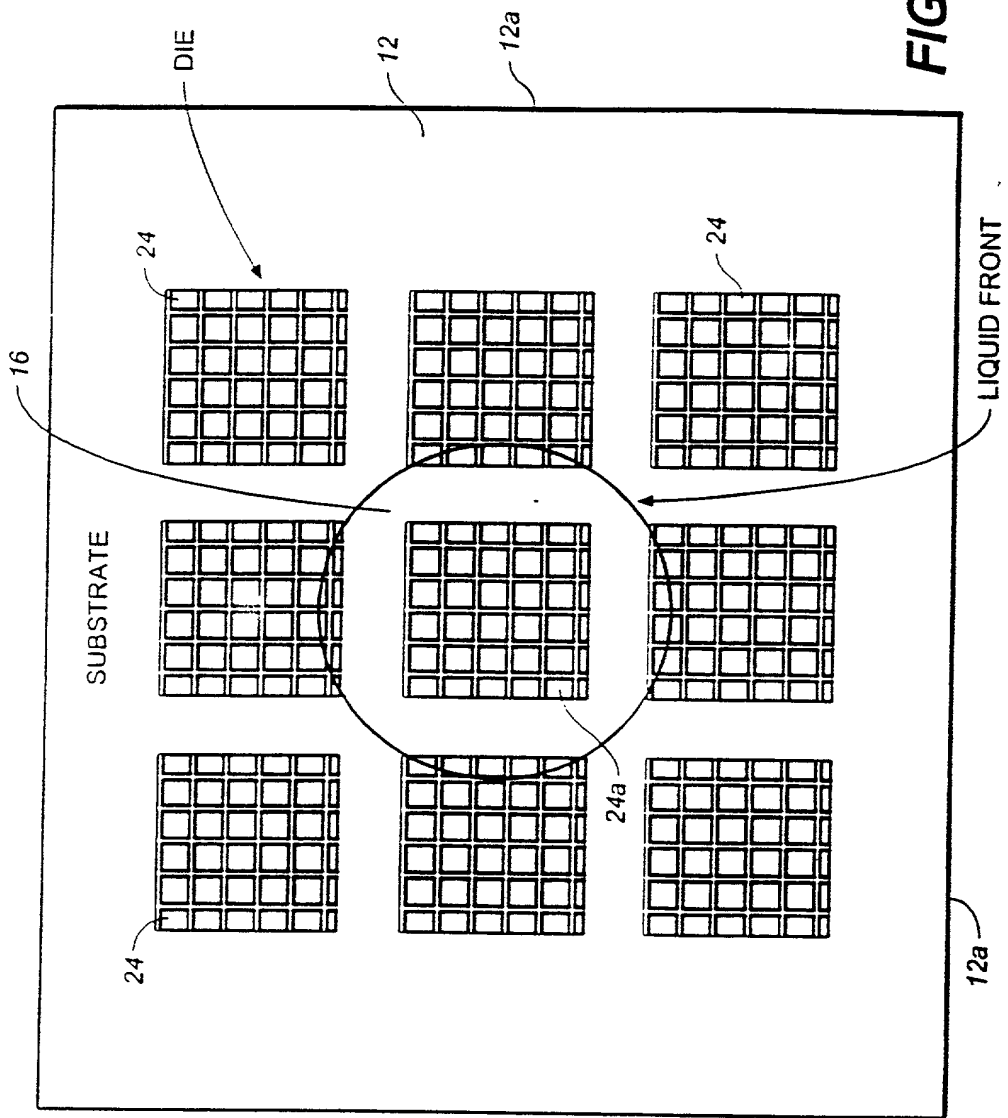


FIG. 3

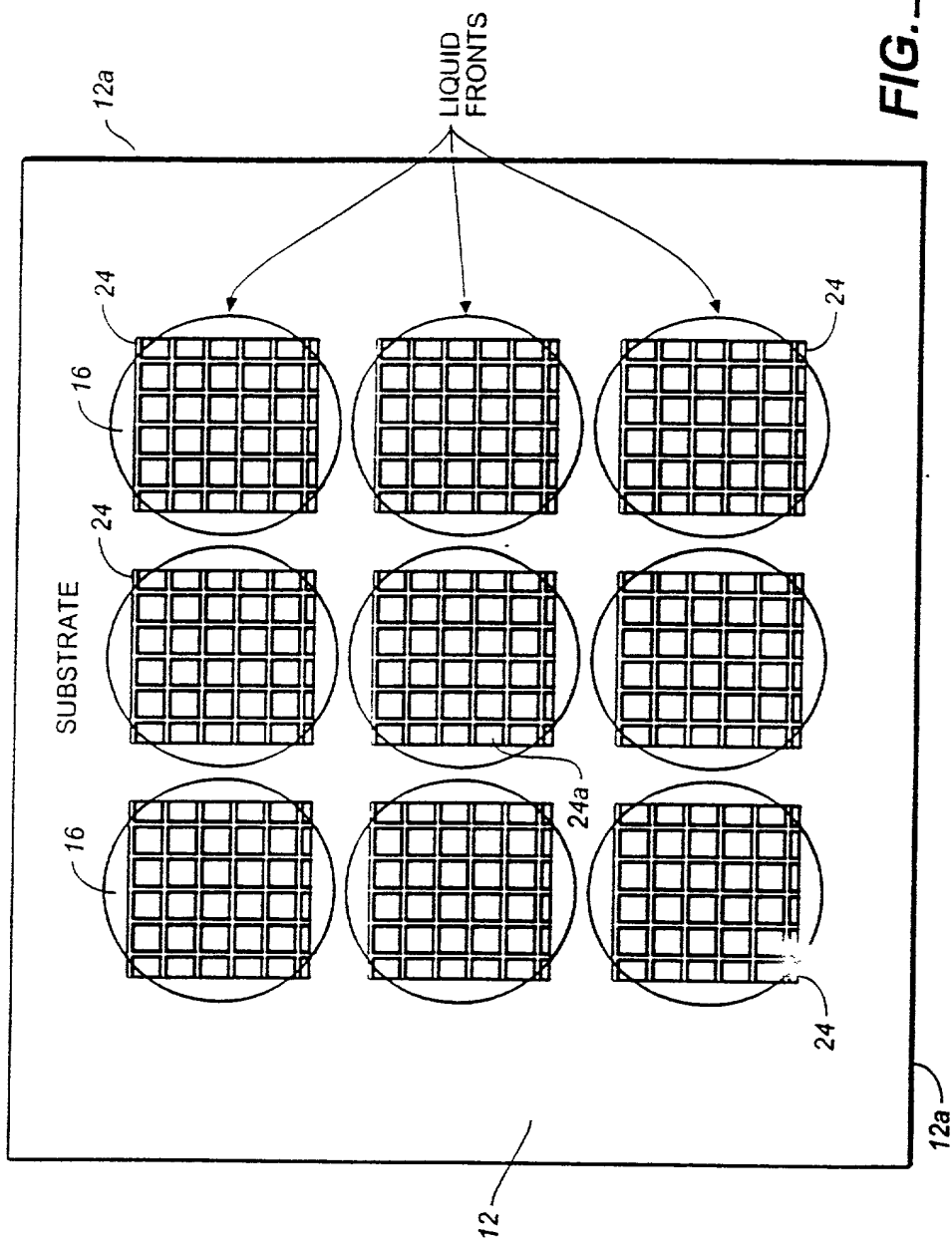
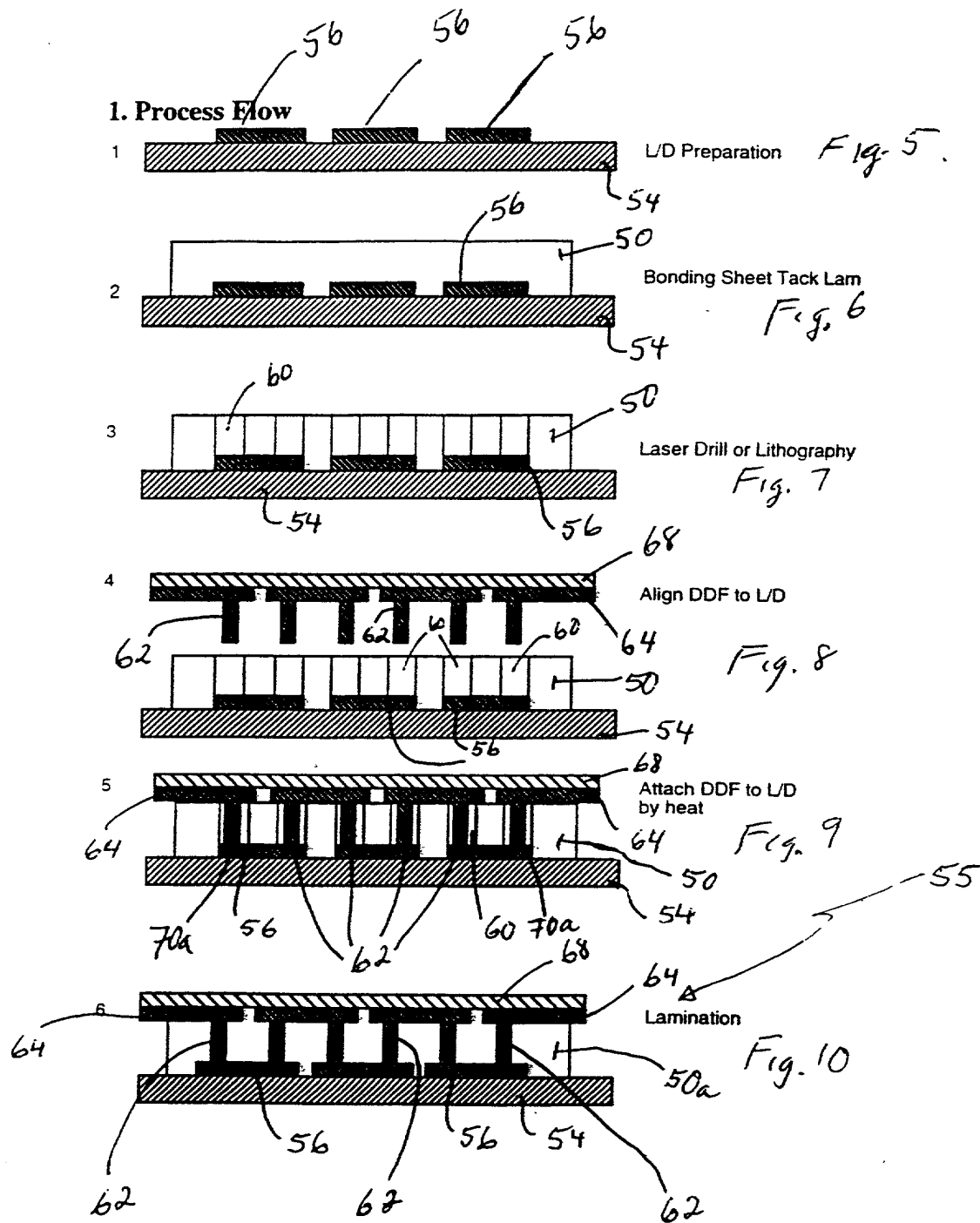
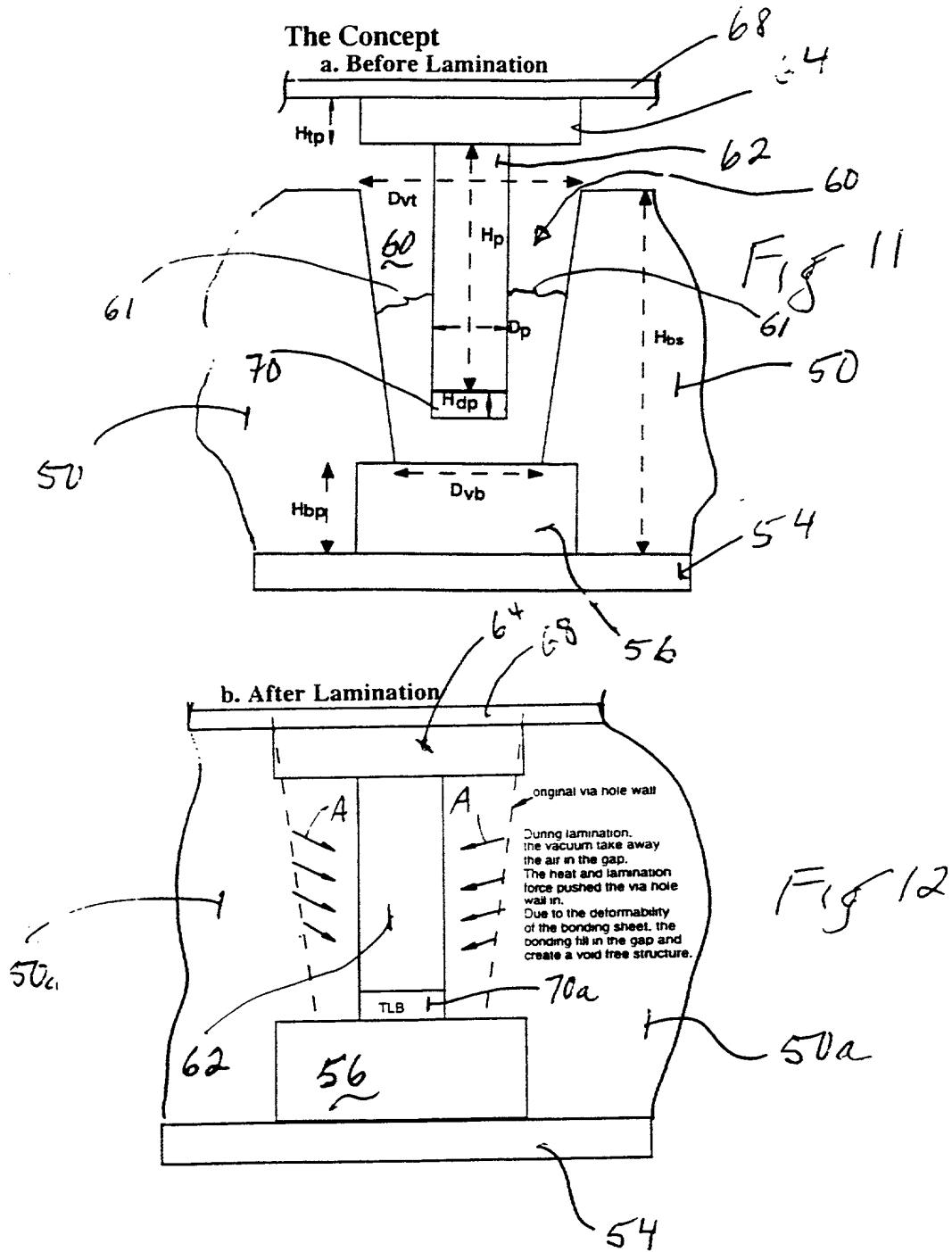


FIG. 4

10065498 020100

1. Process Flow





1006495 020102

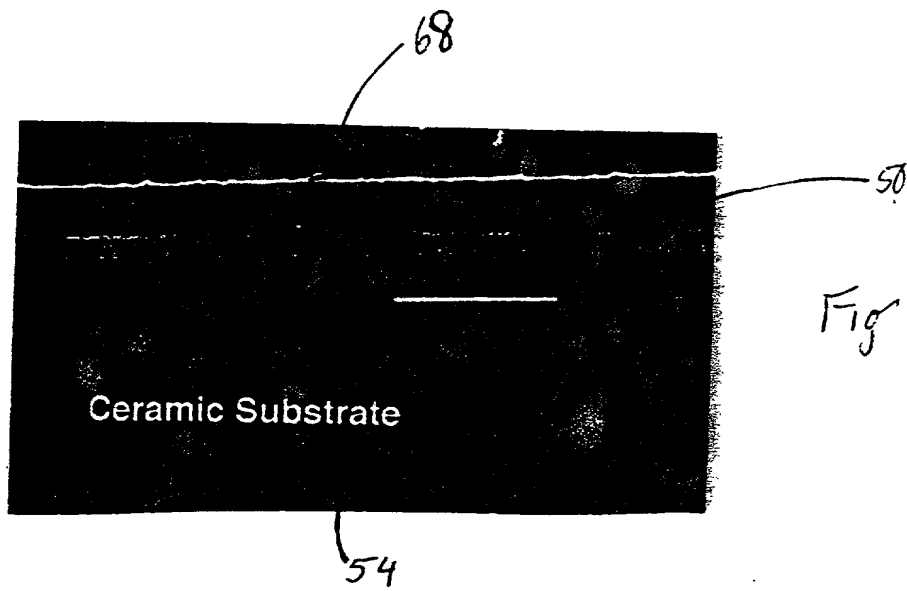


Fig 13

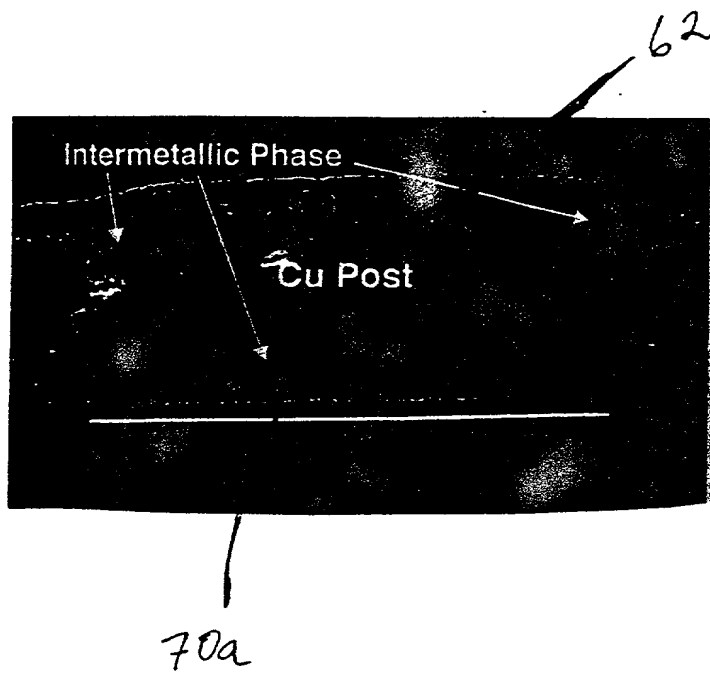
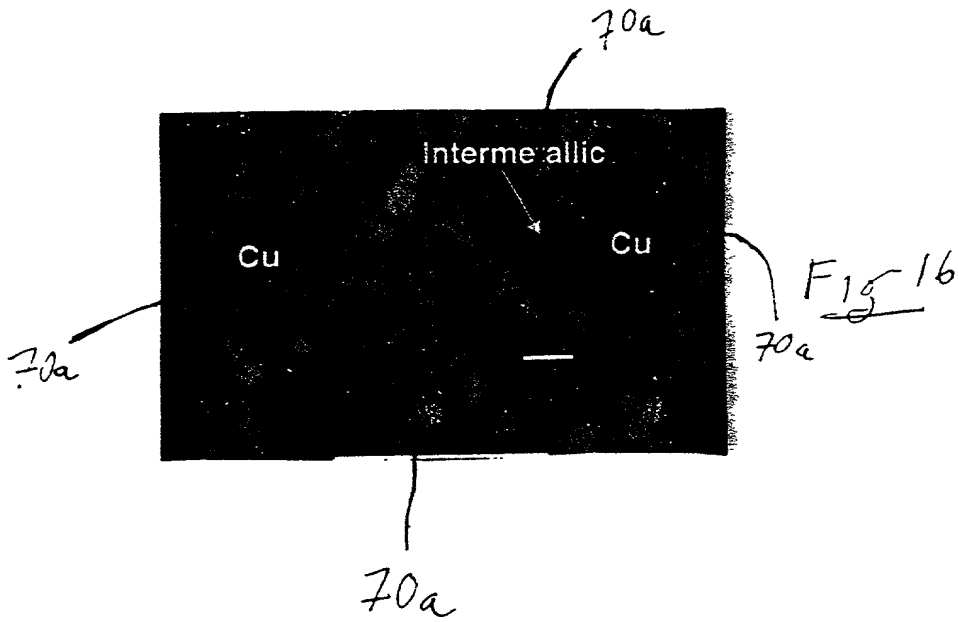
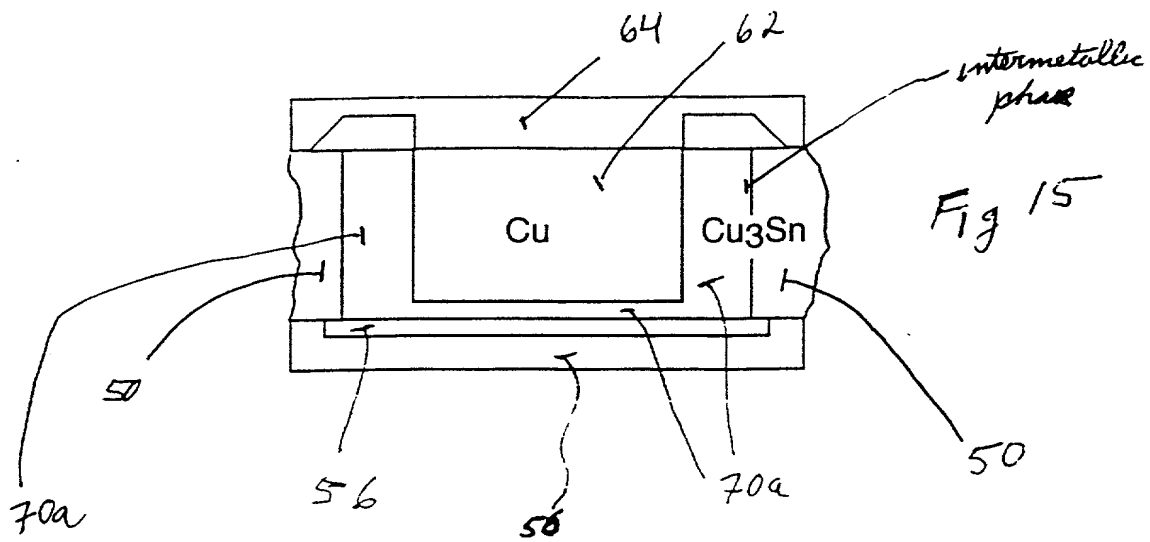


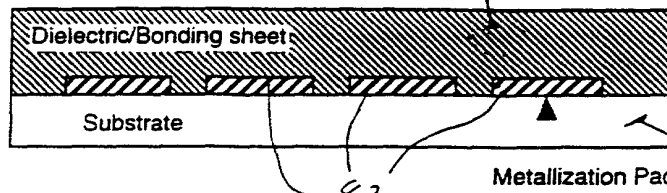
Fig 14

10066496 020102

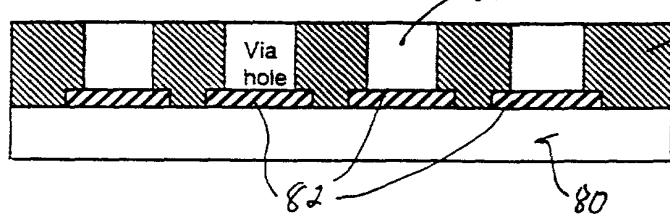


20160555007

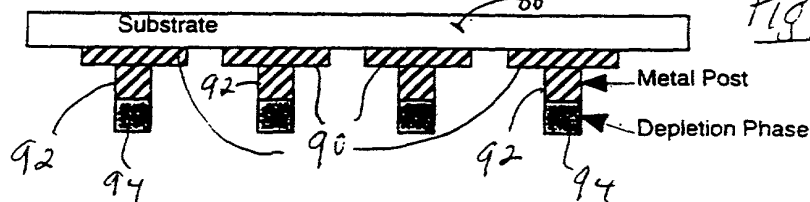
Tack lam the bonding sheet onto bottom substrate with metal pattern



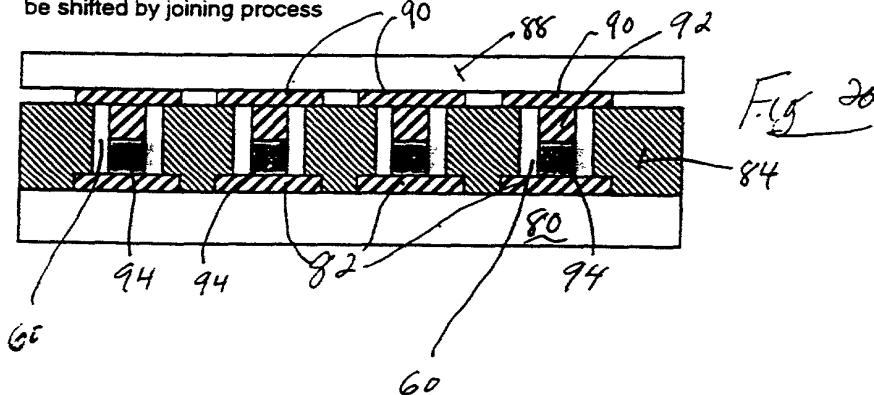
Laser drill via holes on top of metal pad



Top substrate has metal post and depletion phase metal deposited



Top substrate is aligned to the holes on bottom substrate and Laminated under pressure, temperture and in certain period of time. Because the post is anchored by the via hole, the alignment will not be shifted by joining process



After lamination at suitable temperature for both bonding sheet and Transient Liquid Alloy Joints, the final structure has a filled via with metal post embedded inside intermetallic wall.

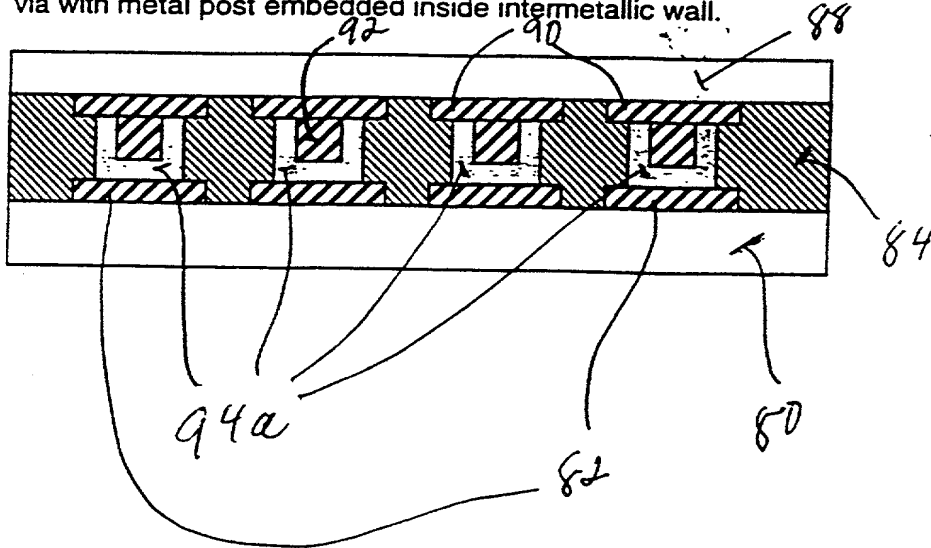


Fig 21

1005497 520102
201026 55155001

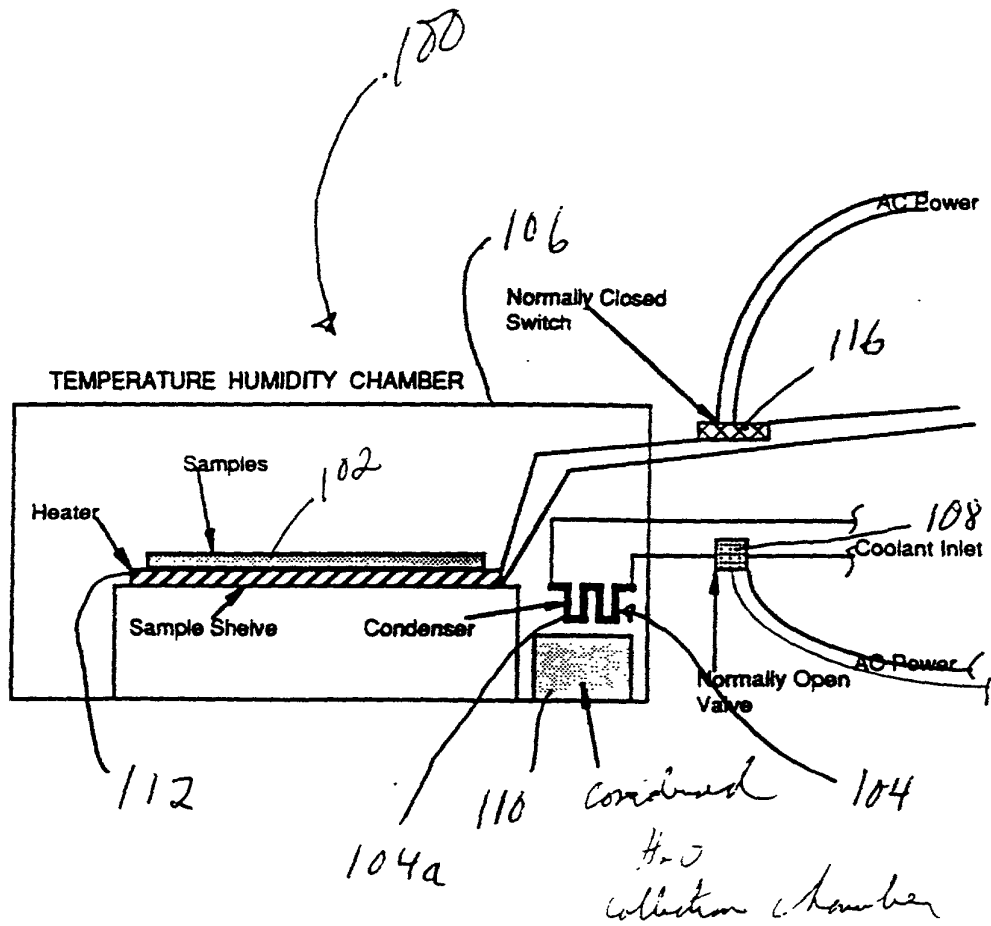


Fig 22

1006456 3549300T

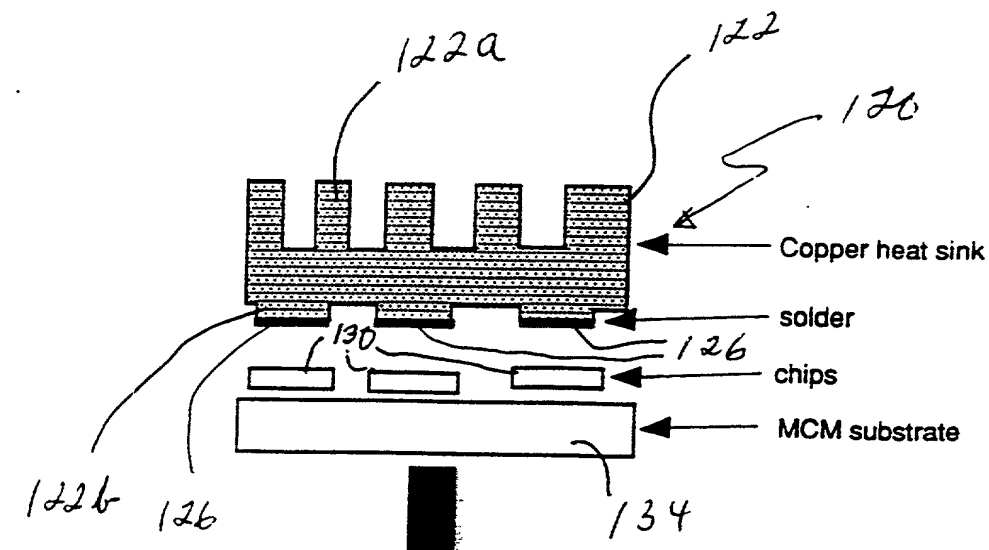
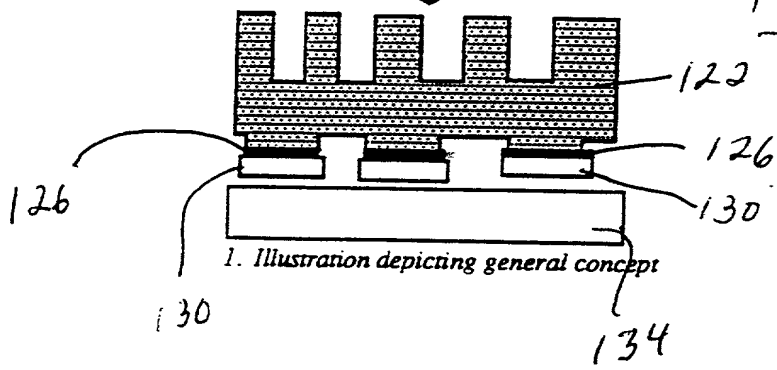
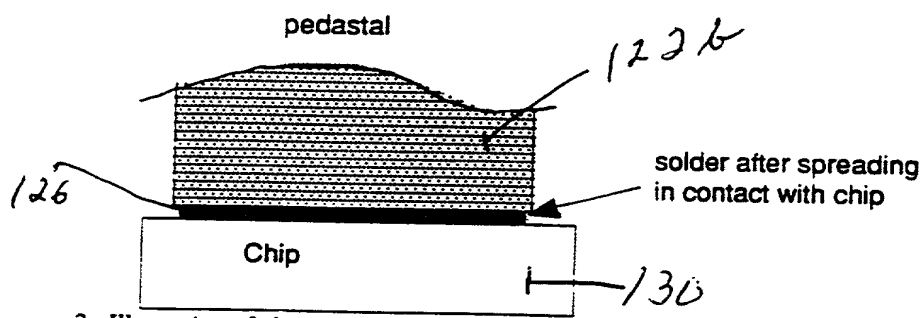


Fig. 23

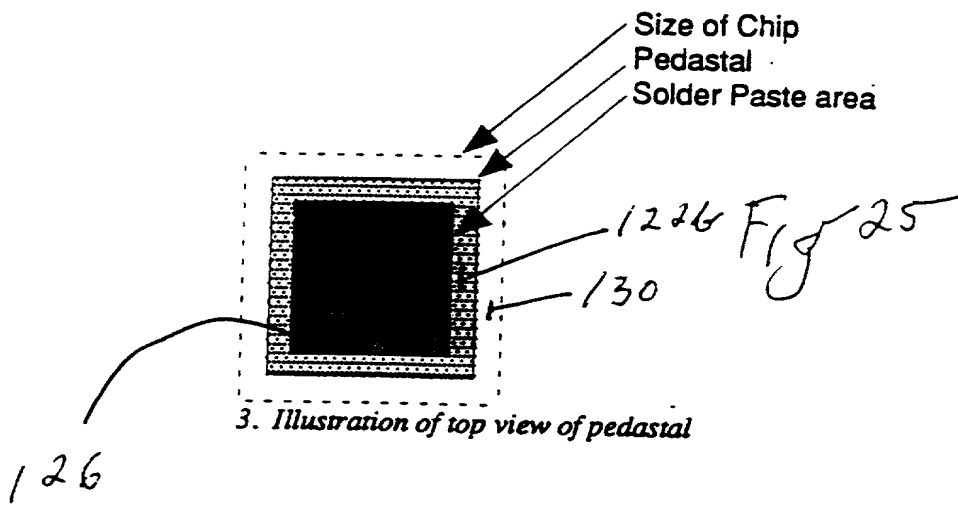


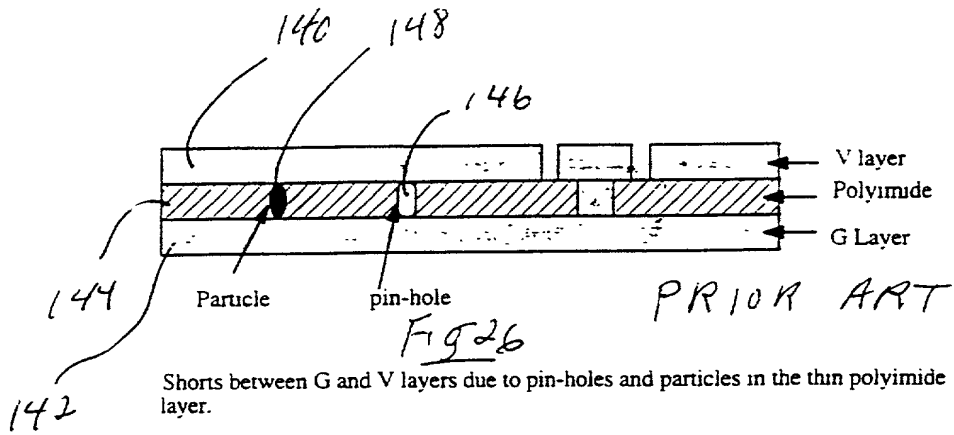
1. Illustration depicting general concept



2. Illustration of close view of solder pedestal in contact with chip

Fig 24





The New Process

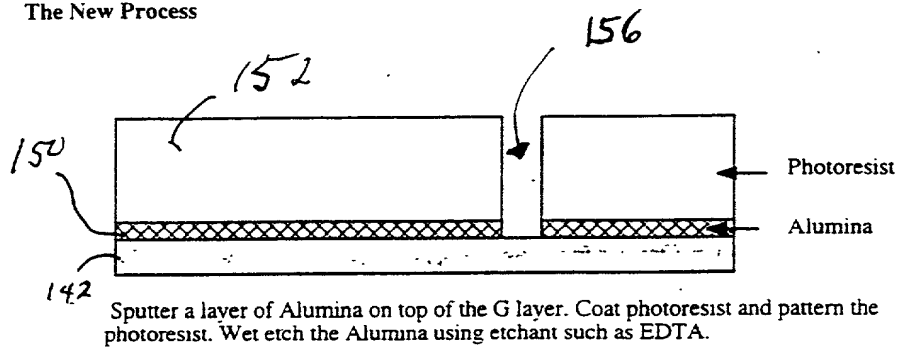


Fig 27

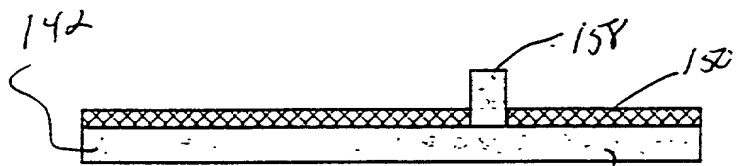
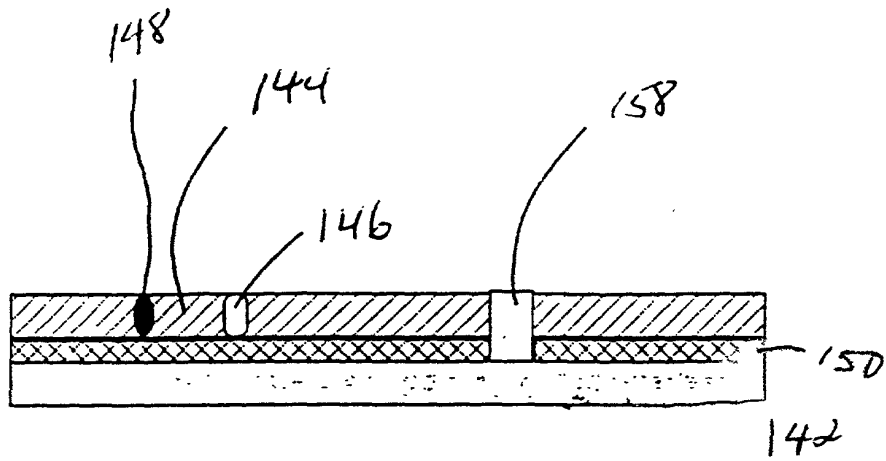


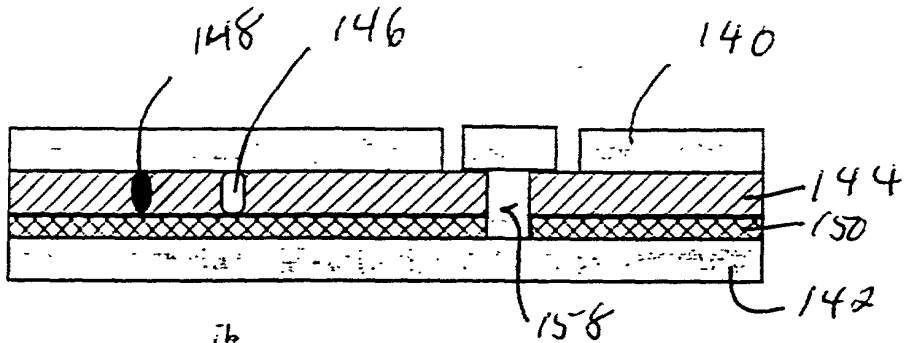
Plate the via and Strip the photoresist.

Fig 28



Coat polyimide, and then planarize and expose the vias.

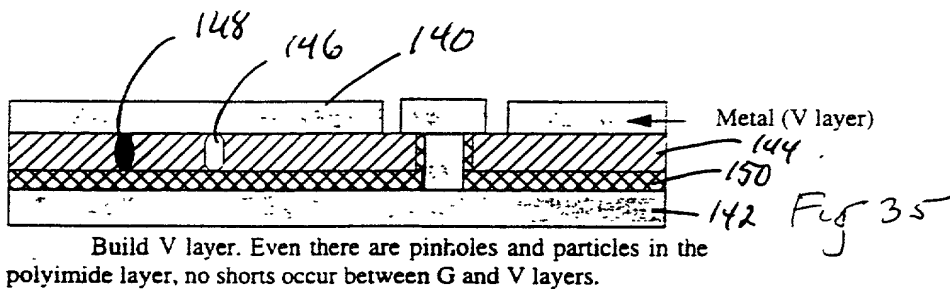
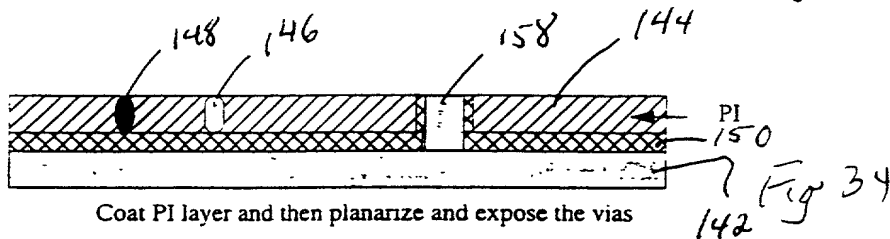
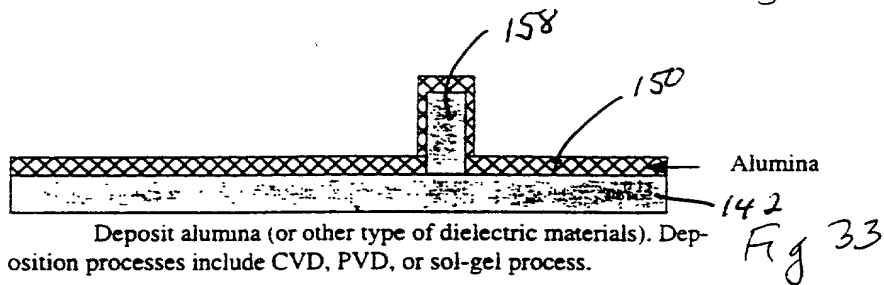
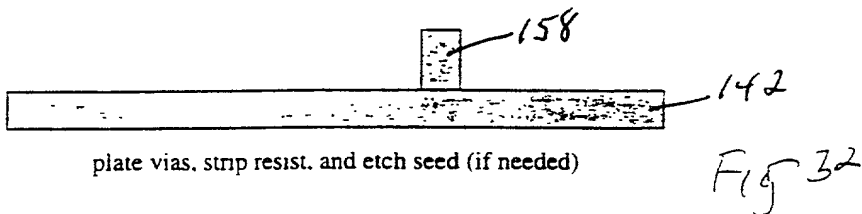
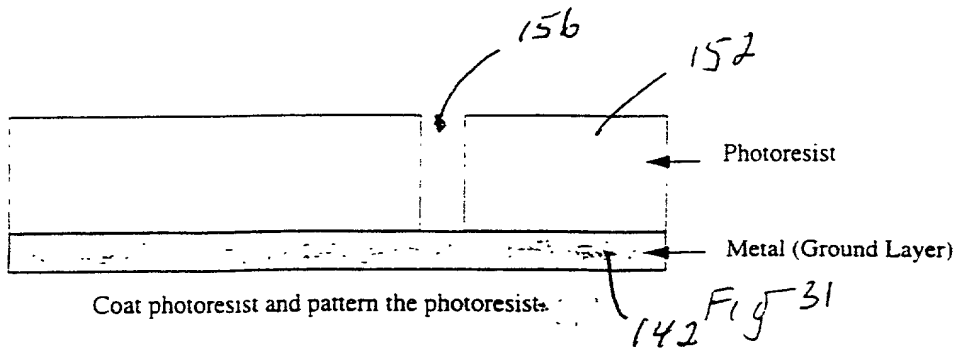
Fig 29



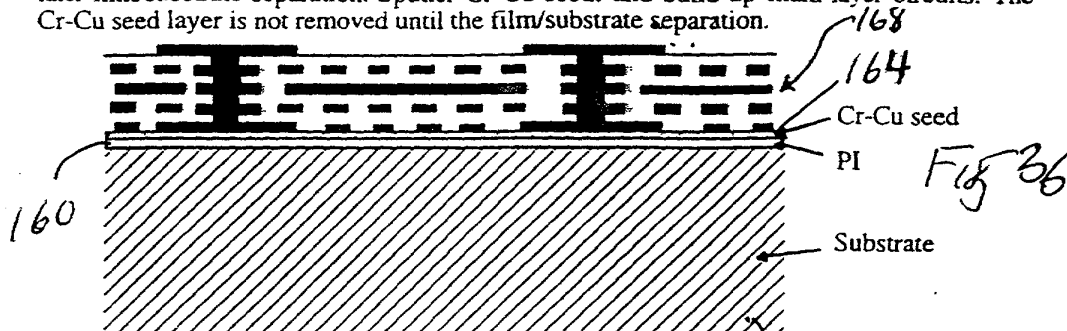
Build V layer. Even there are pin-holes and particles in the polyimide layer, no shorts occur between G and V layers.

Fig 30

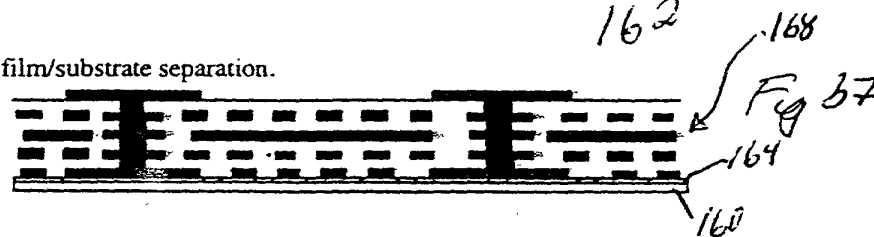
EO 12812-2 "35493007



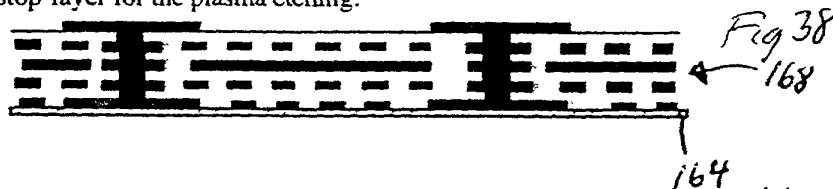
Coat a polyimide layer on top of a substrate. The substrate may be pre-treated for later film/substrate separation. Sputter Cr-Cu seed, and build up multi-layer circuits. The Cr-Cu seed layer is not removed until the film/substrate separation.



After film/substrate separation.



The polyimide layer is etched away using oxygen plasma. The Cr-Cu seed layer serves as the stop-layer for the plasma etching.



After wet etch of Cr-Cu seed.



Fig 39

Fig. 40 Coat a polyimide layer on top of a substrate and sputter Cr-Cu seed on top of the polyimide. The substrate may be pre-treatment for later film/substrate separation. The seed is etched away after completing the first metal pattern layer. Multi-layer circuits are then built.

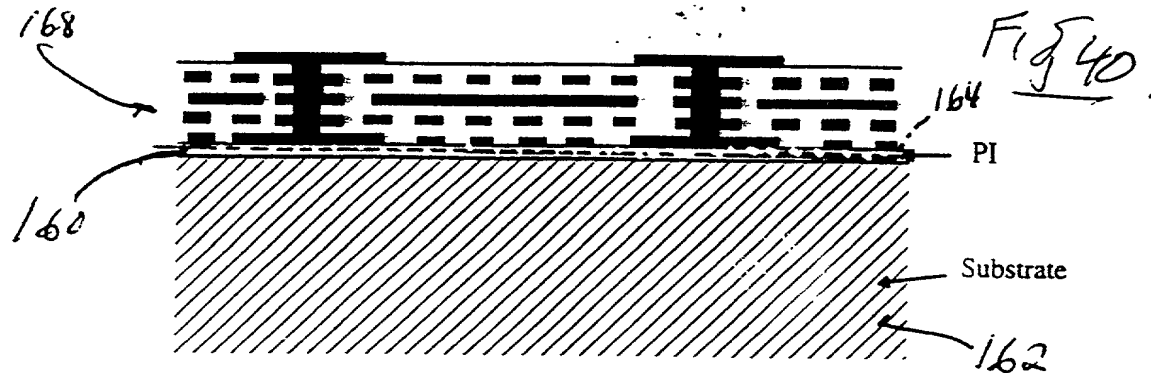


Fig. 41 After film/substrate separation

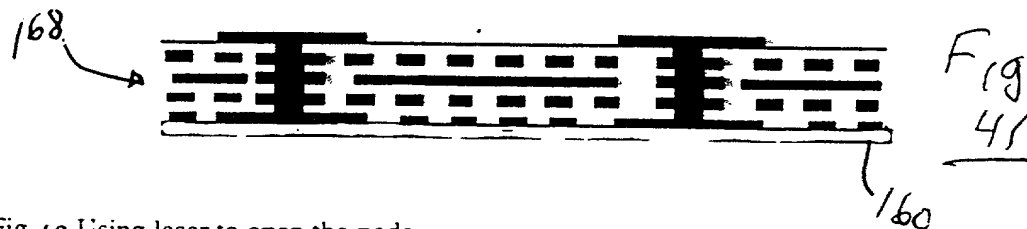


Fig. 42 Using laser to open the pads

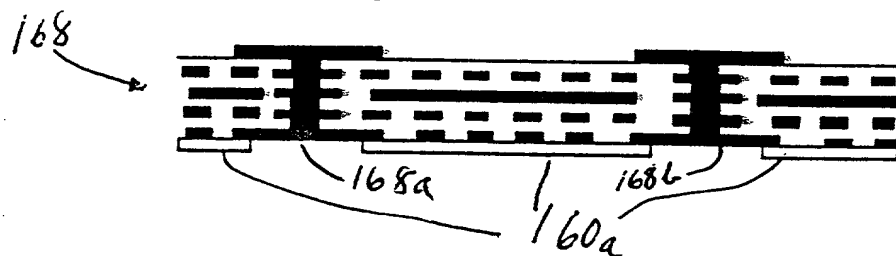


Fig 42

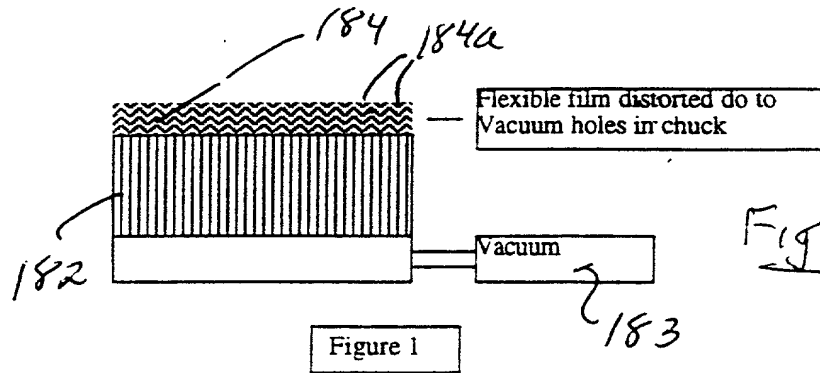


Fig 43

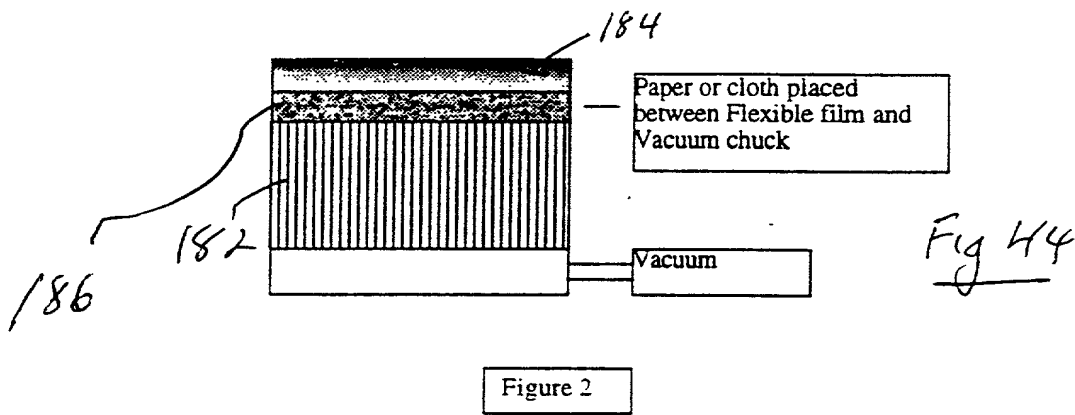


Fig 44

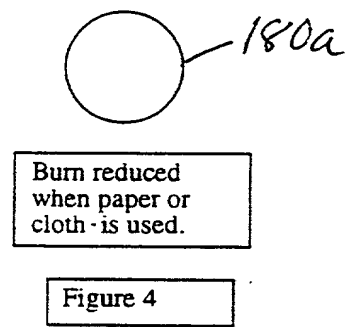
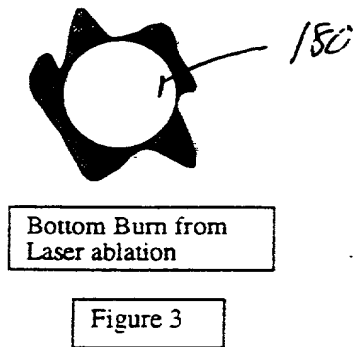
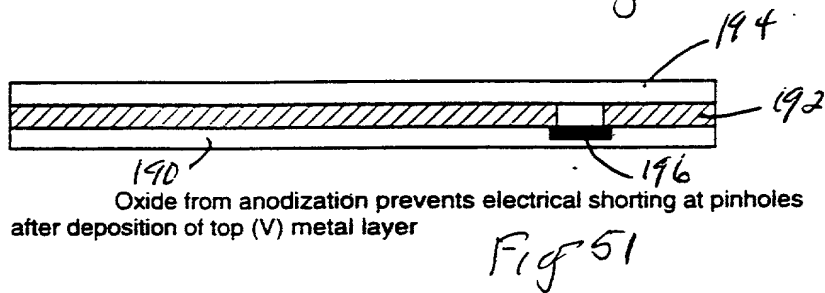
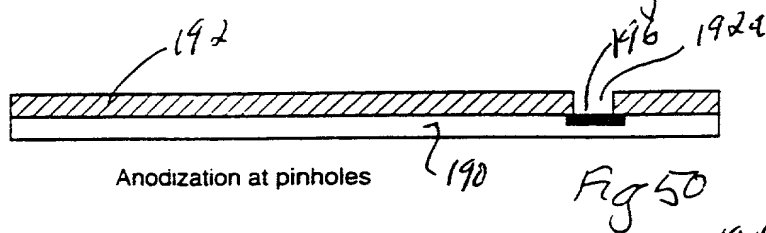
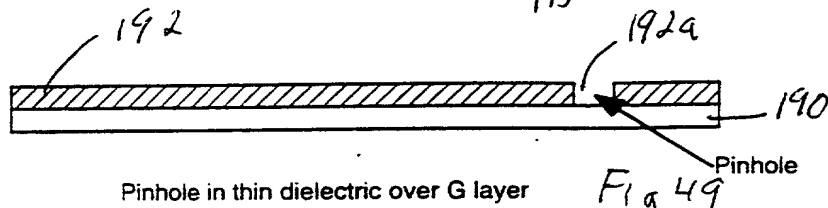
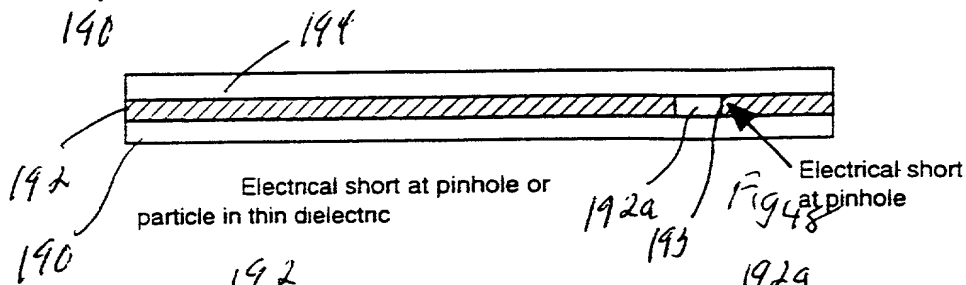
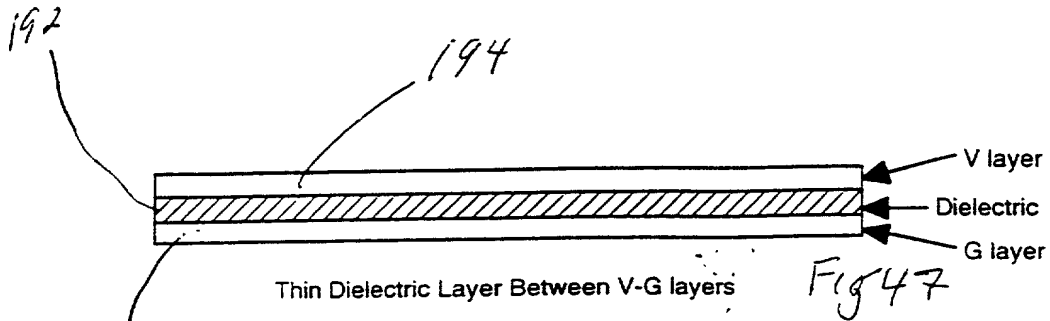


Fig 45

Fig 46



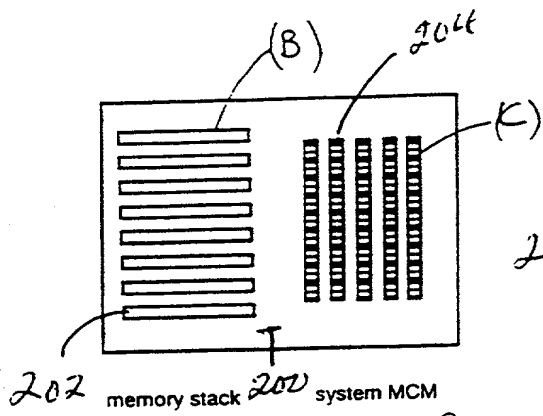


Fig 52A

Case (I)

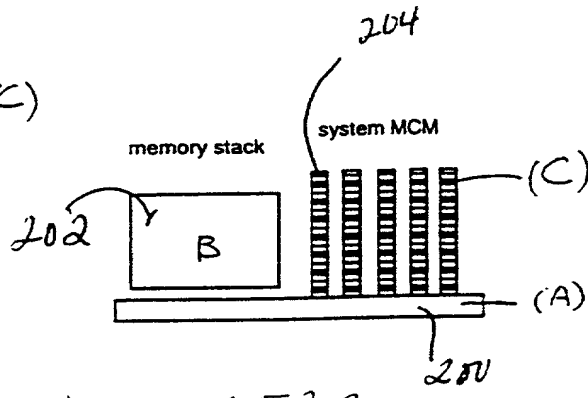


Fig 52B

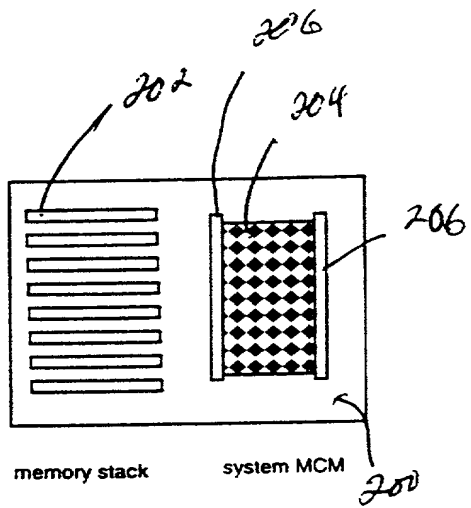


Fig 53A

Case (II)

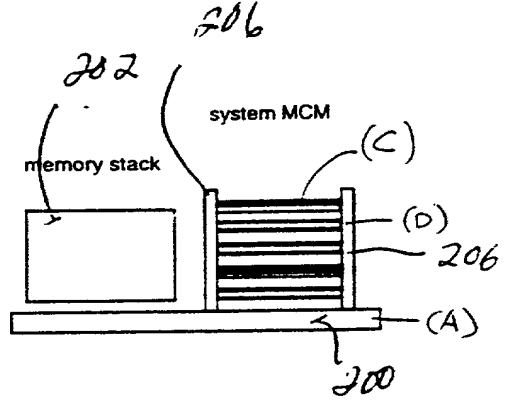


Fig 53B

10065496.020102

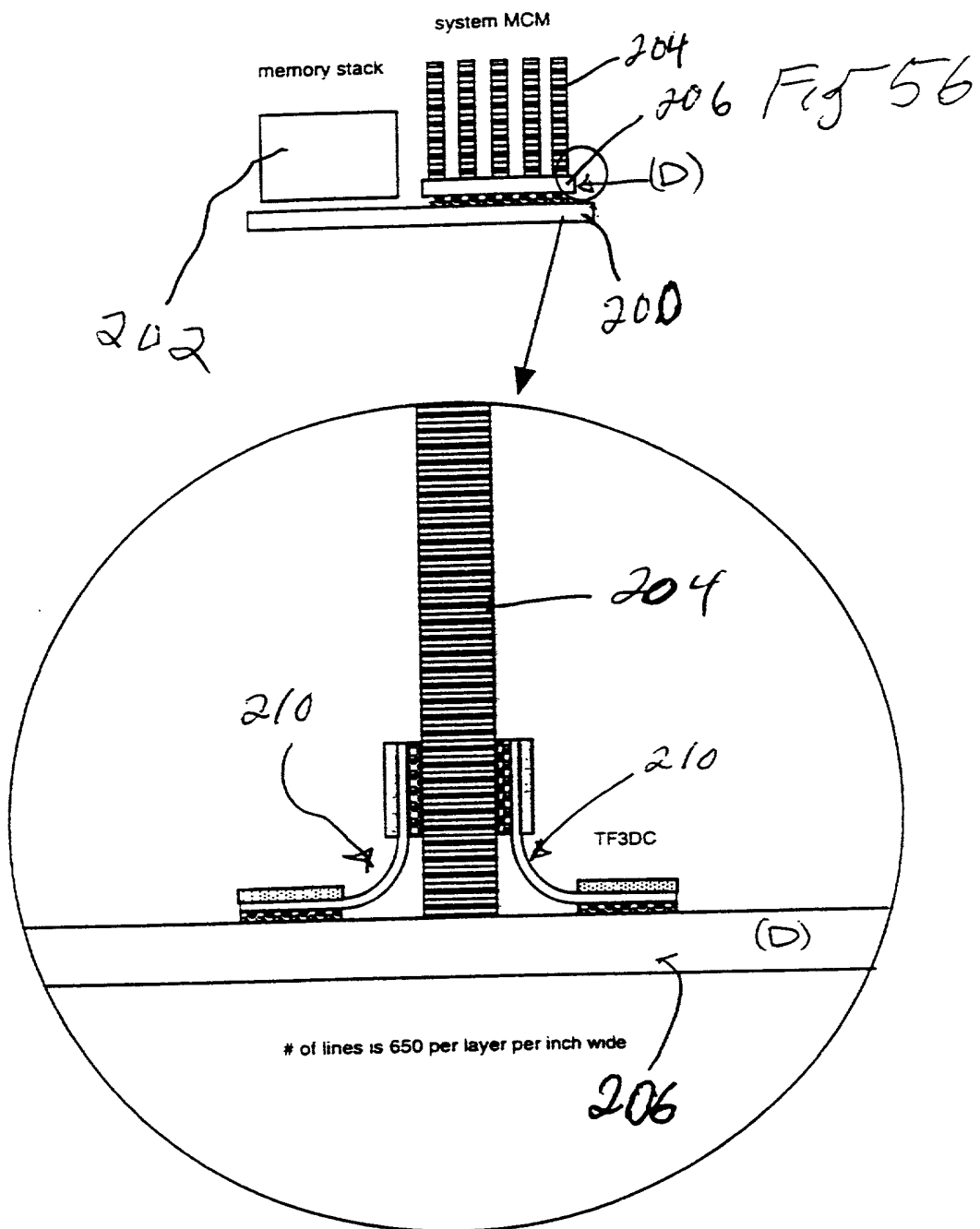


Fig 57

1006495-020102

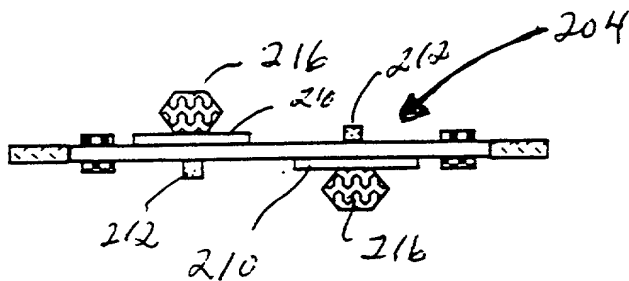
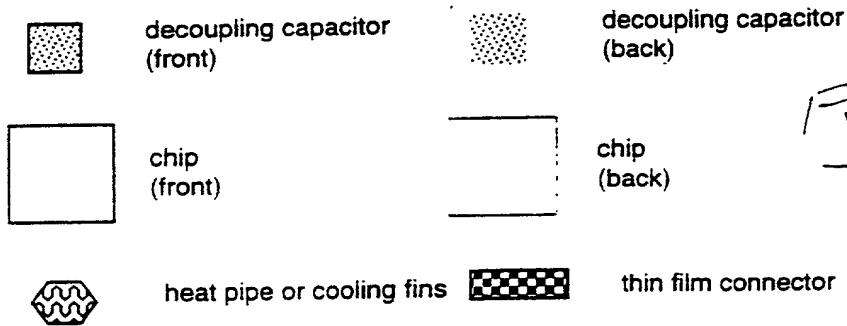
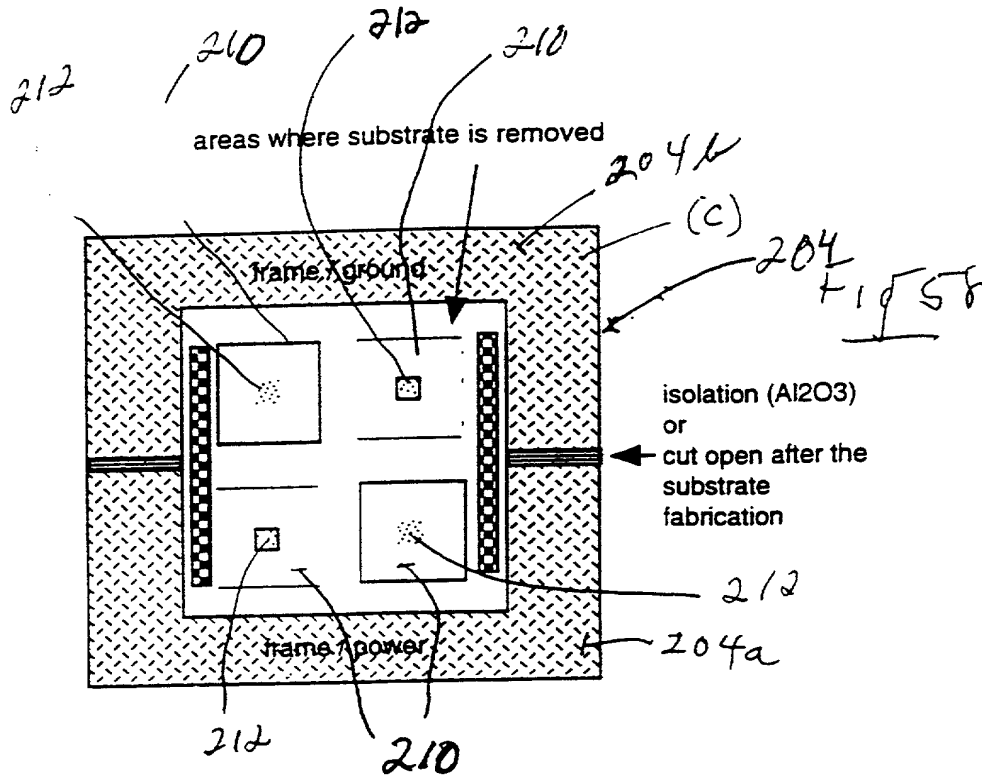
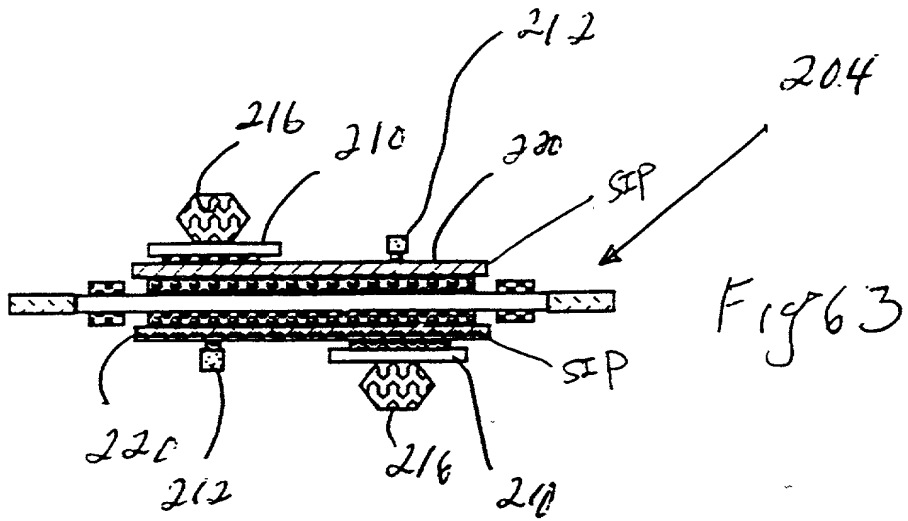
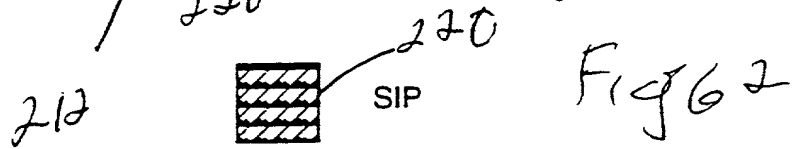
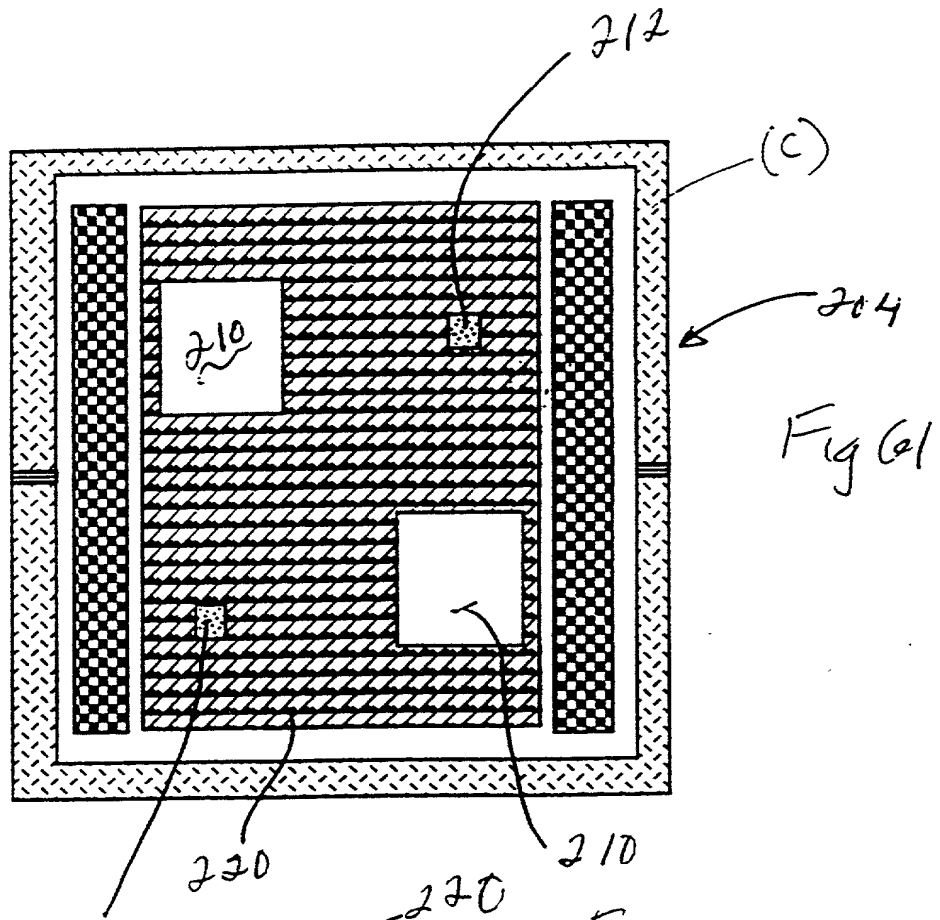


Fig 59

Fig 60



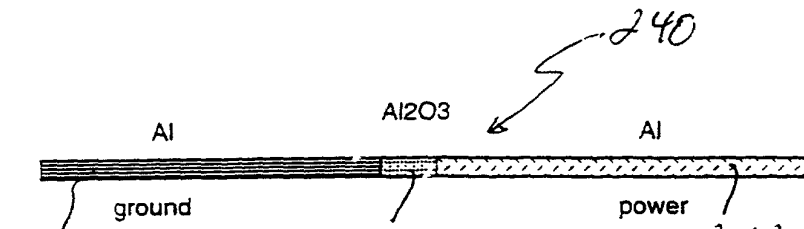


Fig 64

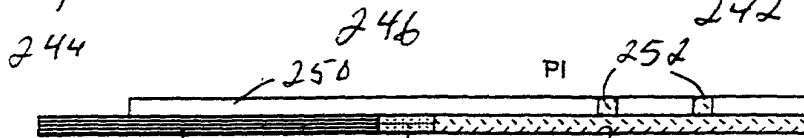


Fig 65

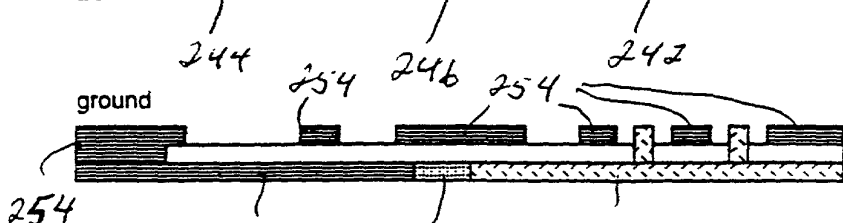


Fig 66

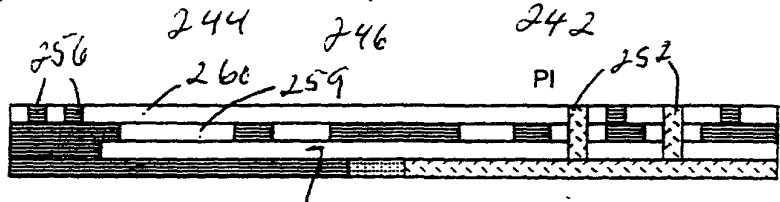


Fig 67

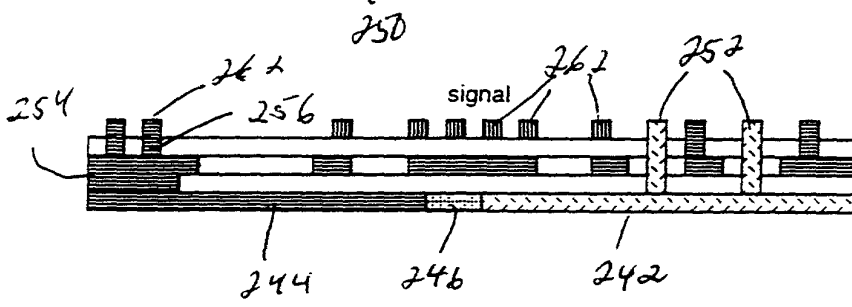


Fig 68

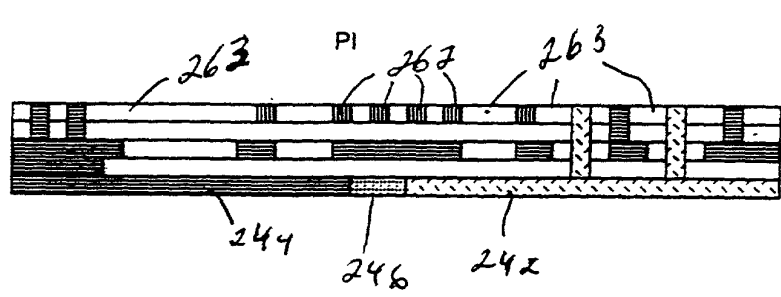


Fig 69

1006455-020402

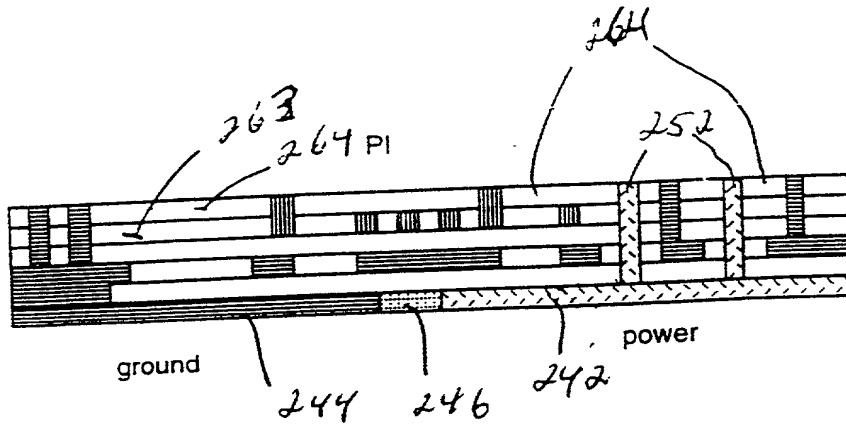


Fig 70

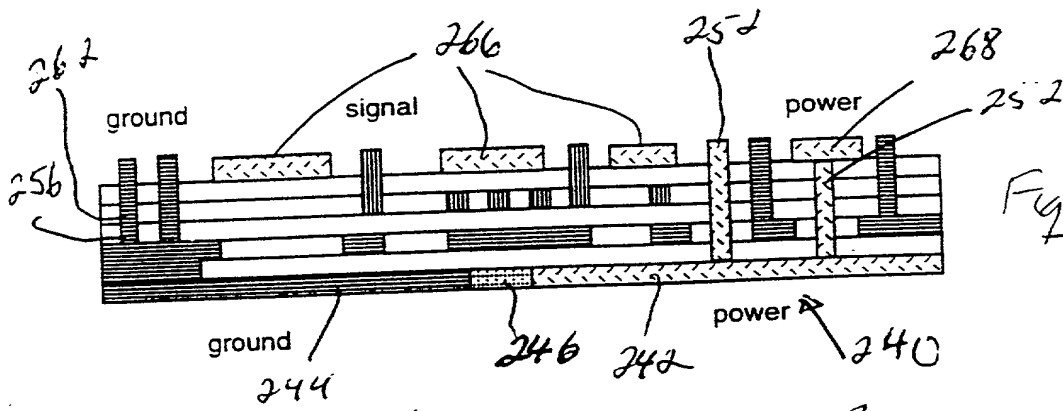


Fig 71

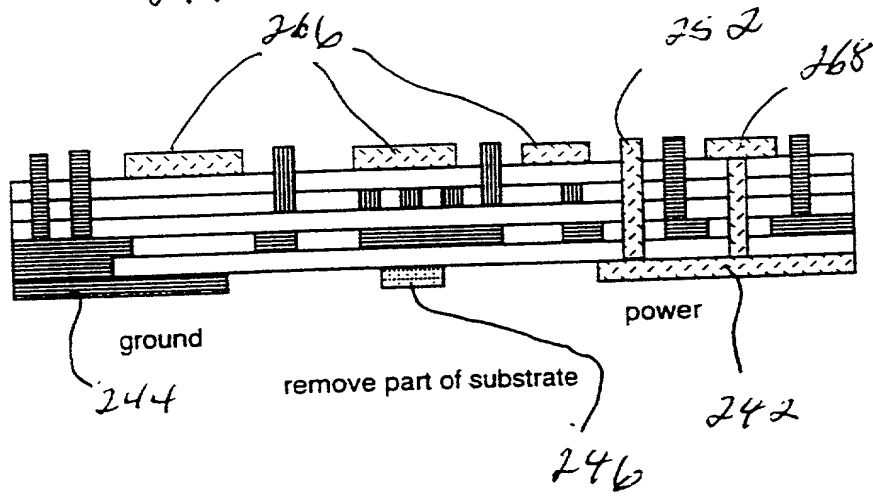


Fig 72

Traditional process for anisotropic conductive film (ACF) connection process for joining two substrate.

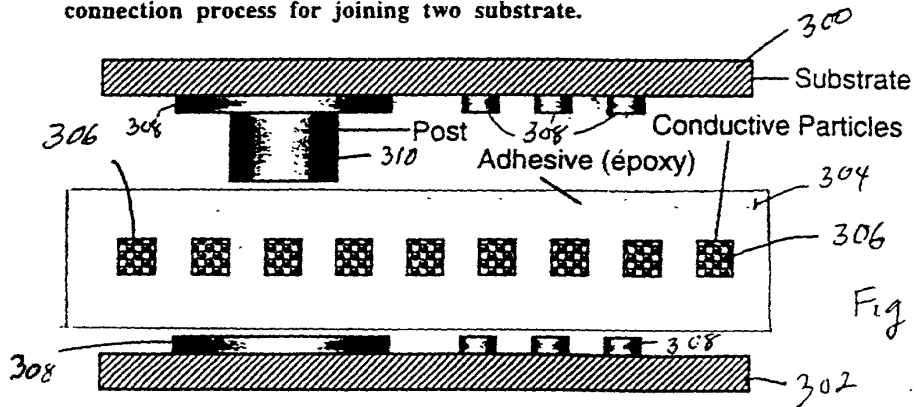


Fig. 76

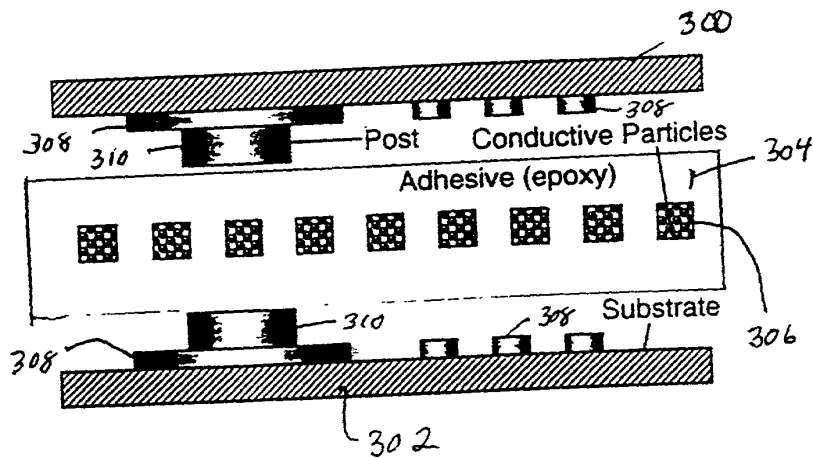


Fig 77

1066495-020302

ACF connection after lamination under high pressure and high temperature in traditional ACF process

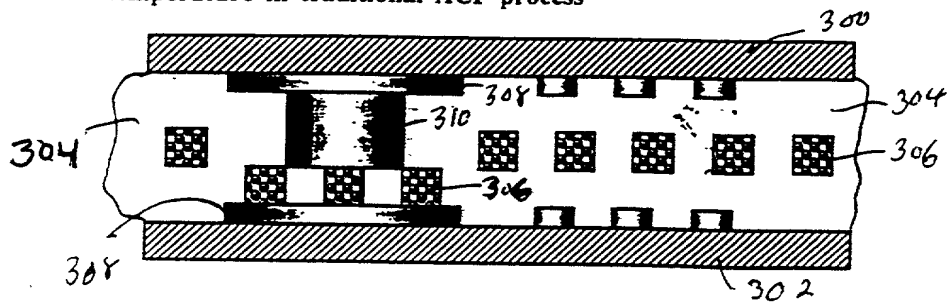


Fig 78

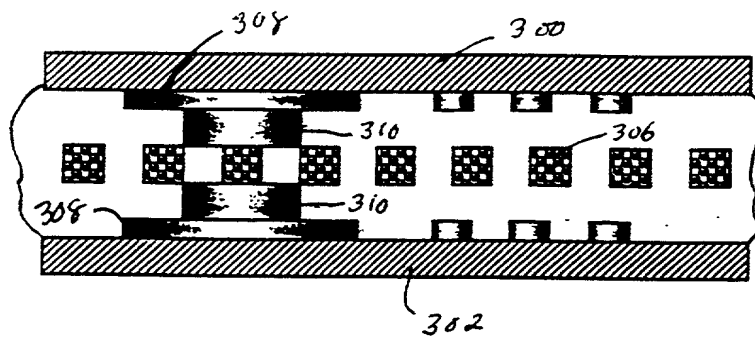
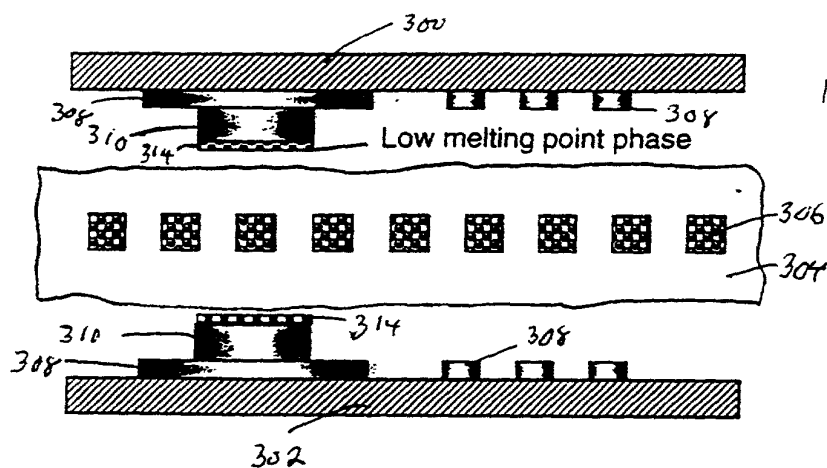
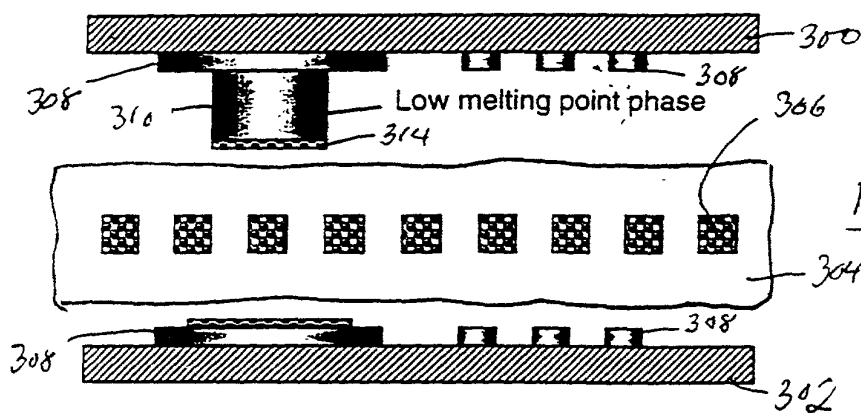
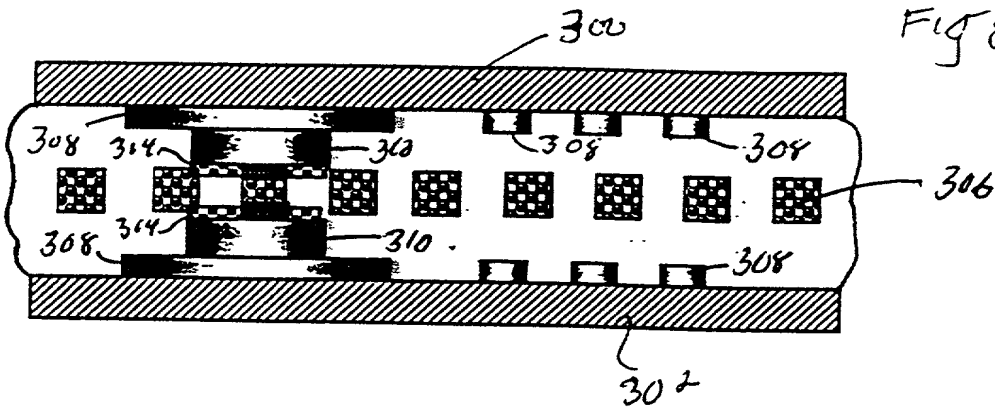
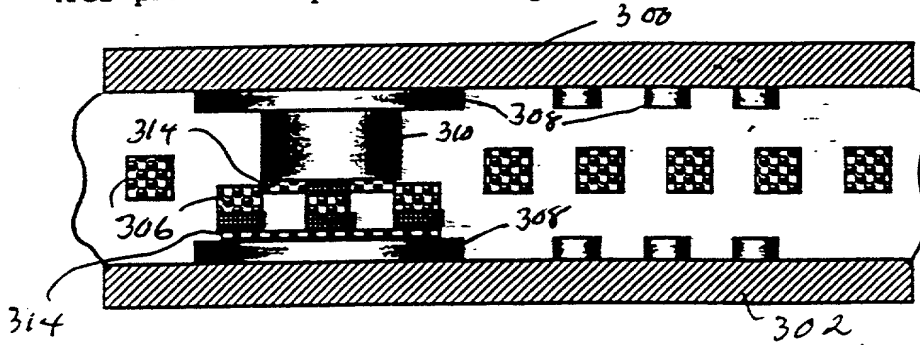


Fig 79

Low resistance ACF joints by depositing a thin layer of low-melting-point metal that will form intermetallic compound/alloy between post material and conductive particles in ACF.



After joining process (high pressure and high temperature), intermetallic/alloy formed at the interface of post and conductive particles. The intermetallic/alloy will decrease the contact resistance from traditional ACF process and provide a stronger mechanical bond.



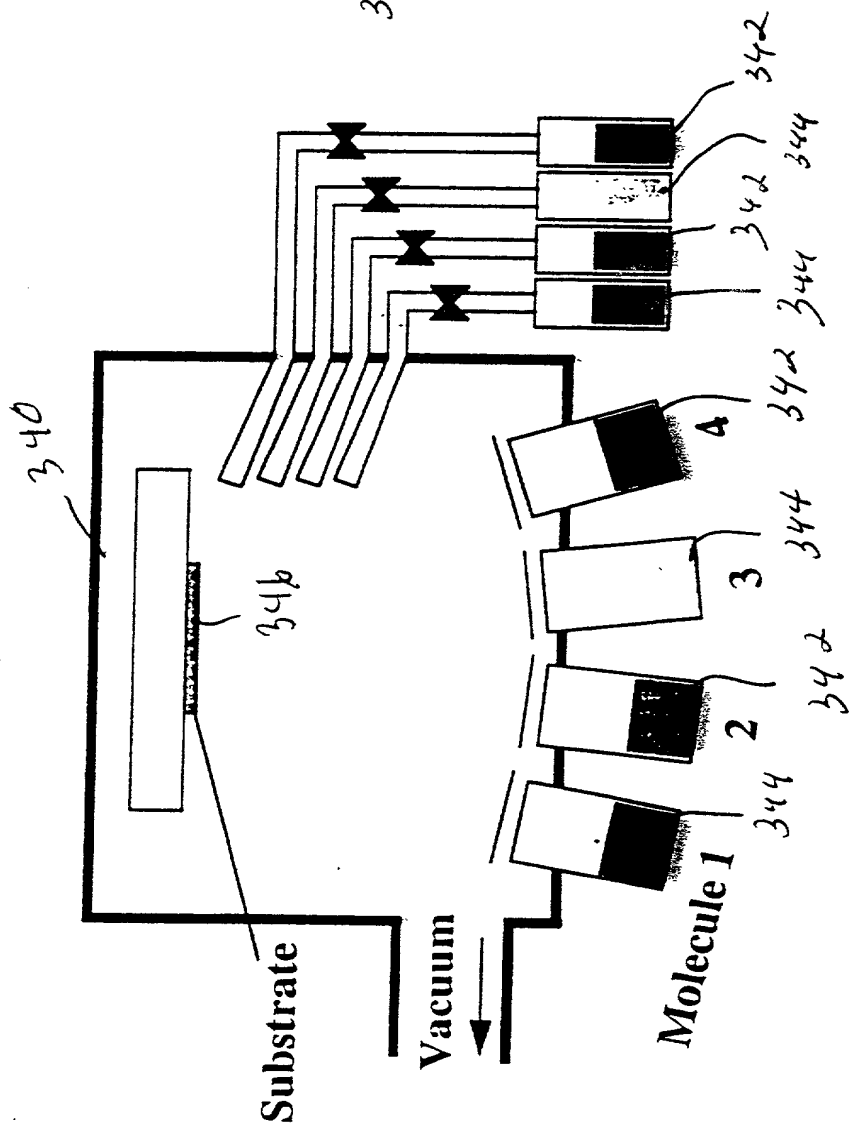


Fig 84A

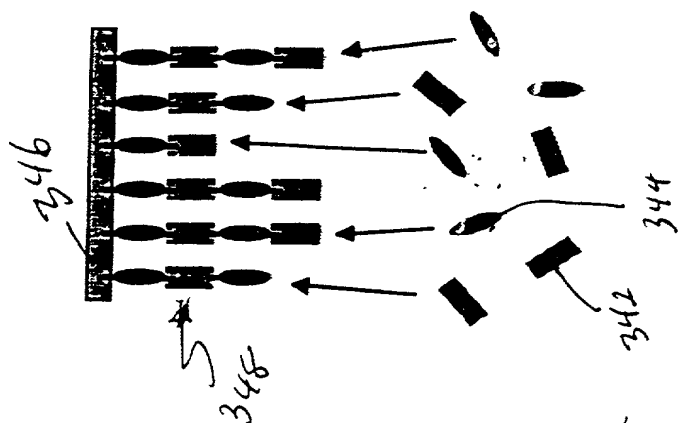
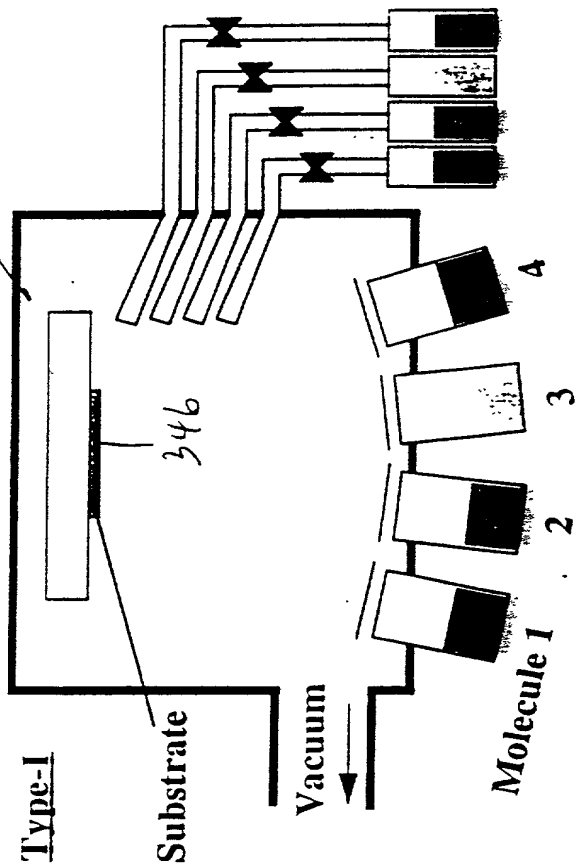


Fig-84B

Fig. 85A



Type-I

Substrate

Vacuum

Molecule 1

2

3

4

Type-II

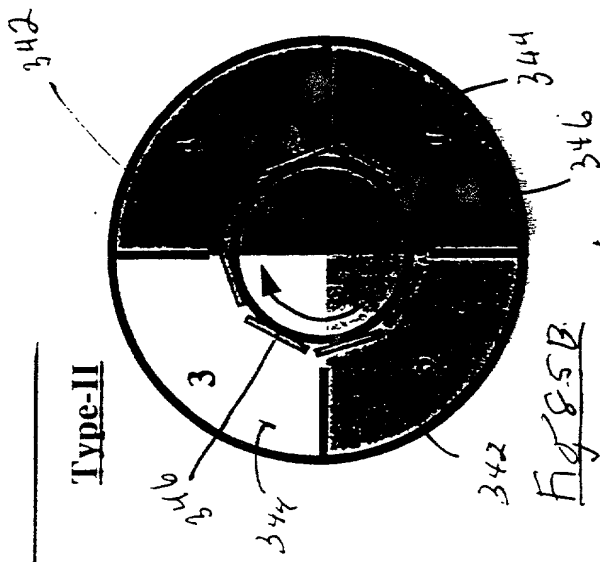


Fig. 85B

Fig. 85E

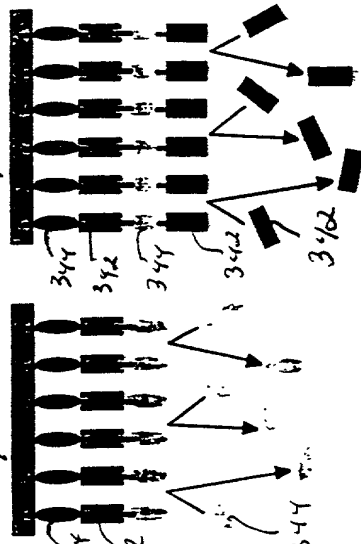
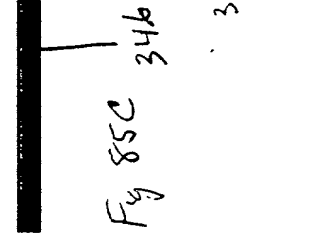
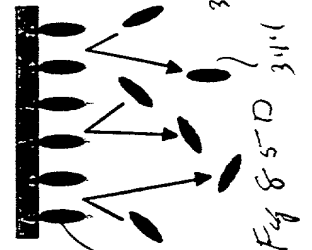
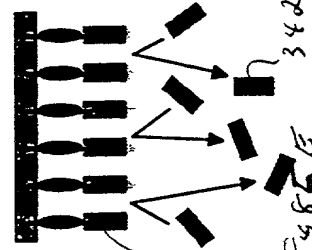
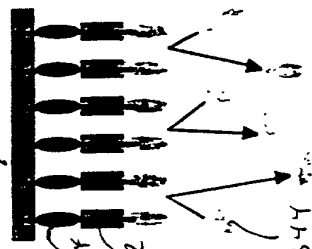


Fig. 85F



Vapor Phase Deposition Vs. Spin coating

	Spin coating	Vapor Phase Deposition	
		CVD	MLD
-Coverage Controllability	Low	High	High
-Thickness Accuracy/Uniformity	Low	Medium	High
-Deposition Rate	High	Medium	Low
-Molecular-level Controllability	Low	Medium	High
-Selective Deposition	No	Yes	Yes
Selective Molecular Alignment	No	Yes	Yes

(High & Yes are preferable)

-Conformable coverage and Thickness accuracy/uniformity

-CVD/MLD are superior to Spin Coating

- Low ϵ insulator with strong adhesion

-MLD may provide high adhesion with the Molecular-Level Controllability

-Options

-CVD/MLD can do # Selective Deposition (hydrophilic/hydrophobic surface)

Selective Molecular Alignment (surface treatment)

may provide further ϵ reduction, process simplification, and low Cu-diffusion

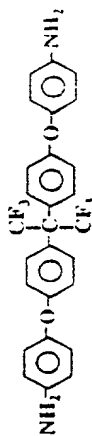
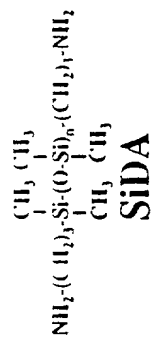
Fig 85H

PMDA

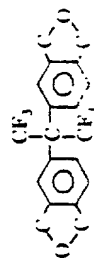
ODA

naphthalene dianhydride (ND)

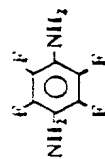
Fig. 86.CC



Bis-OAF



6FDA



VT4-DA

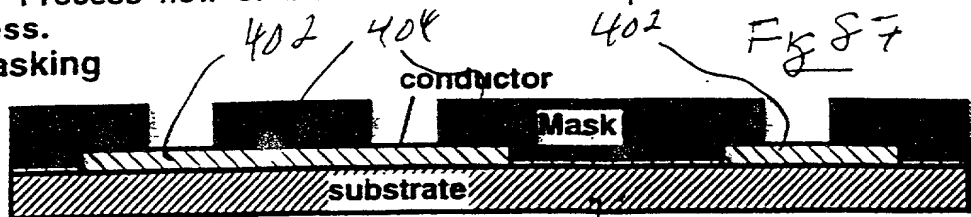
alkylamine-coated Si | ND \Rightarrow Bis-OAF \Rightarrow ND \Rightarrow Bis-OAF \Rightarrow ••• \Rightarrow ND \Rightarrow SiDA

Si | SiDA \Rightarrow 6FDA \Rightarrow Bis-OAF + 6FDA \Rightarrow SiDA

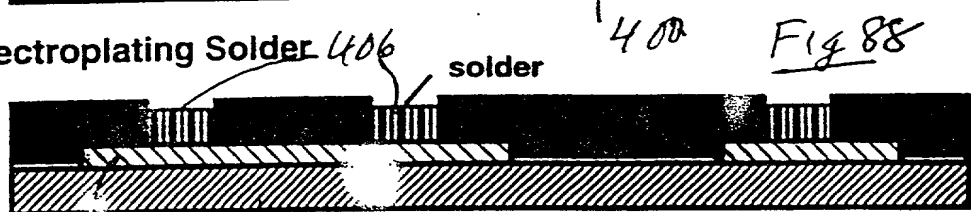
Si | SiDA \Rightarrow ODA \Rightarrow 6FDA \Rightarrow VT4-DA \Rightarrow 6FDA \Rightarrow ••• \Rightarrow ODA \Rightarrow SiDA

Process flow of the resist-free electroplated solder reflow process.

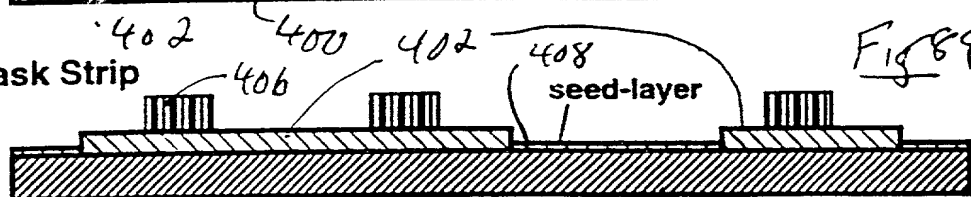
1. Masking



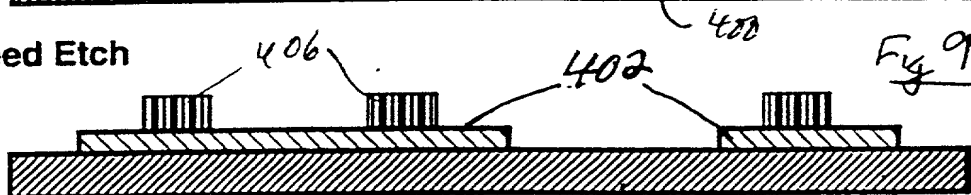
2. Electroplating Solder



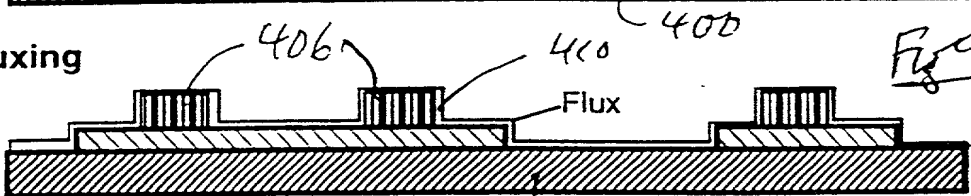
3. Mask Strip



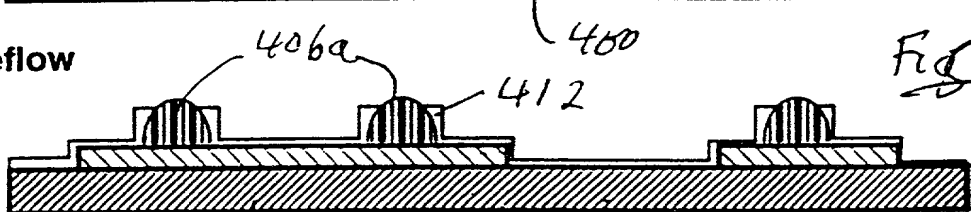
4. Seed Etch



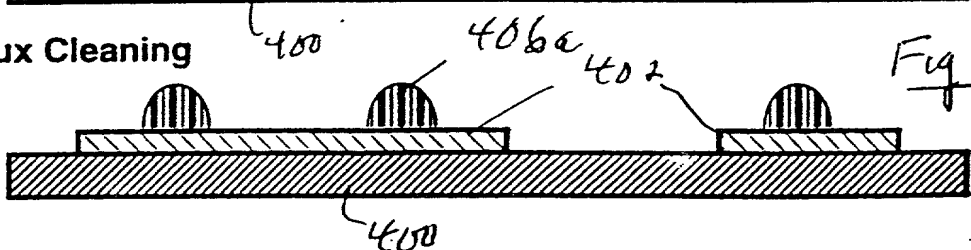
5. Fluxing



6. Reflow

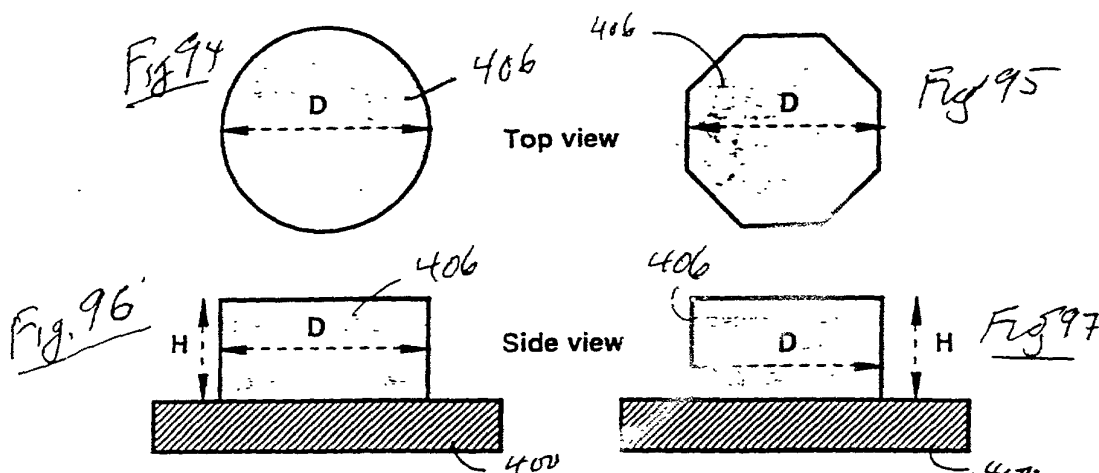


7. Flux Cleaning

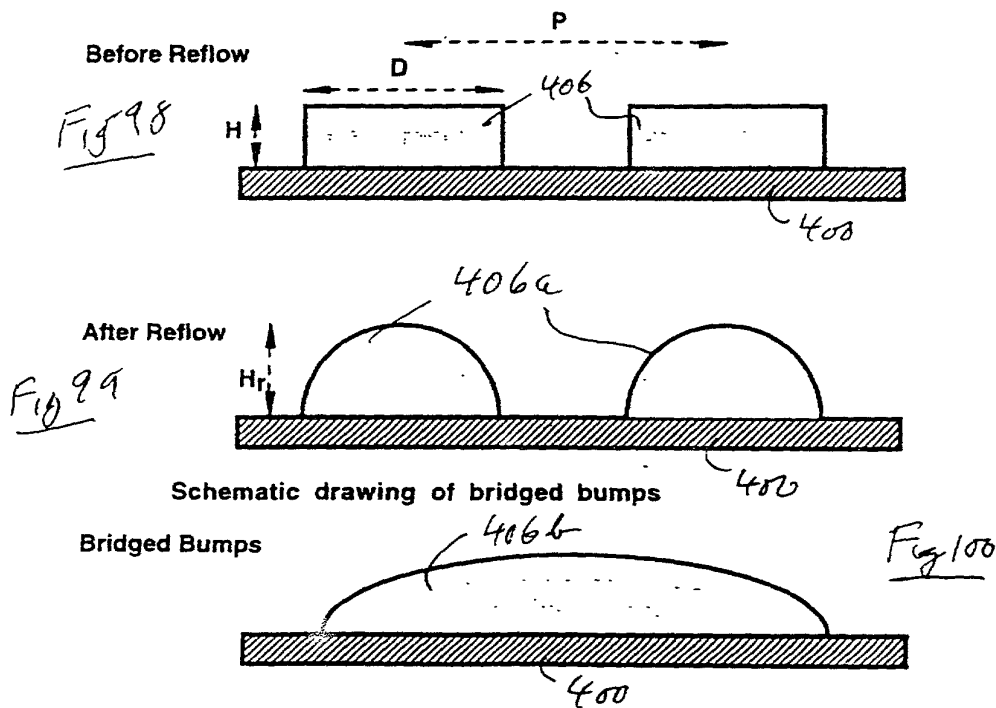


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Geometric dimensions of the electroplated bumps.



Geometric shape change of electroplated solder bumps by reflow process



Direct Plating Process

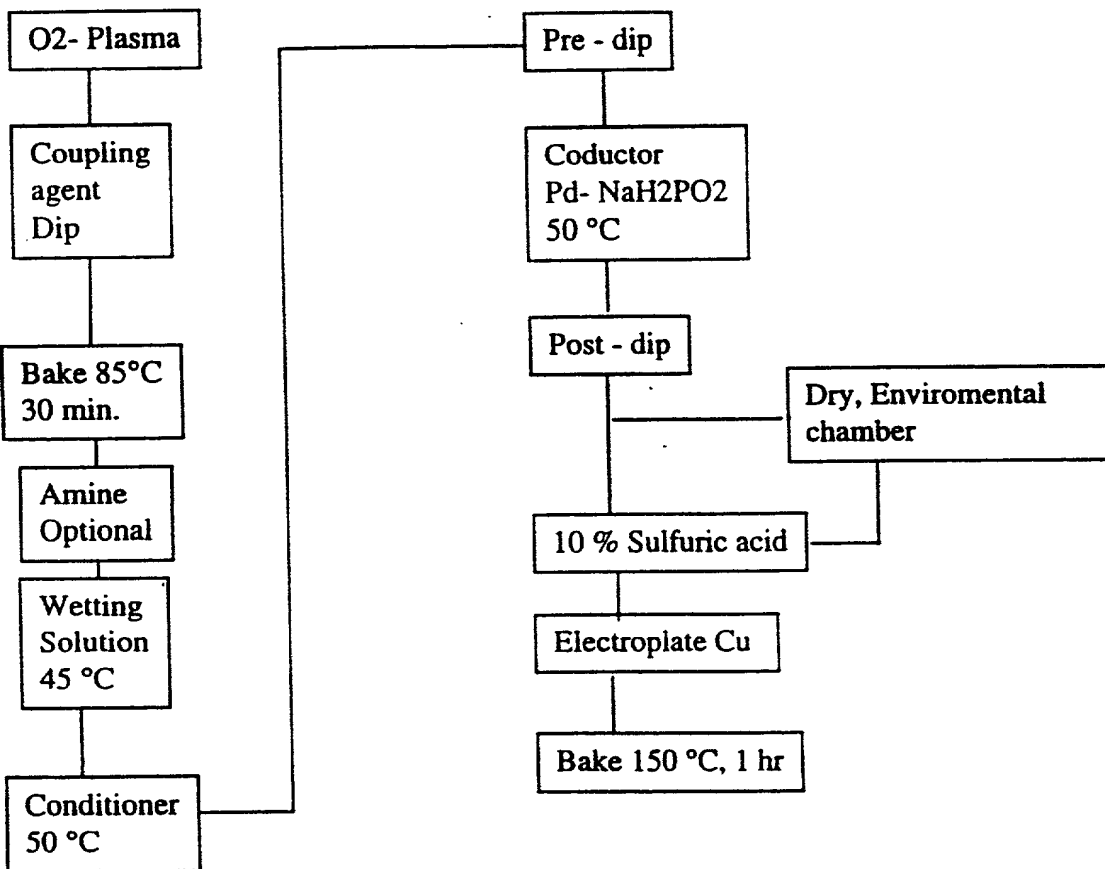


Fig 101A

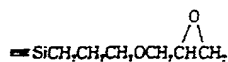
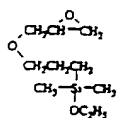
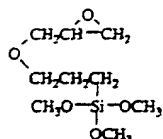


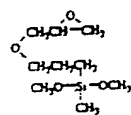
Fig 101B



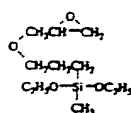
(3-GLYCIDOXYPROPYL)DIMETHYLETHOXY-
SILANE
 $\text{C}_{10}\text{H}_{22}\text{O}_3\text{Si}$



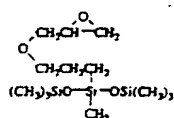
(3-GLYCIDOXYPROPYL)TRIMETHOXY-
SILANE
3-(2,3-EPOXYPROPOXY)PROPYLTRIMETHOXY-
SILANE
 $\text{C}_9\text{H}_{20}\text{O}_5\text{Si}$



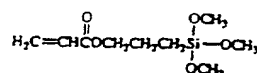
(3-GLYCIDOXYPROPYL)METHYLDIMETHOXY-
SILANE
 $\text{C}_9\text{H}_{20}\text{O}_4\text{Si}$



(3-GLYCIDOXYPROPYL)METHYLDIETHOXY-
SILANE
 $\text{C}_{11}\text{H}_{24}\text{O}_4\text{Si}$



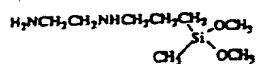
(3-GLYCIDOXYPROPYL)BIS(TRIMETHYL-
SILOXY)METHYLSILANE
 $\text{C}_{13}\text{H}_{32}\text{O}_4\text{Si}_3$



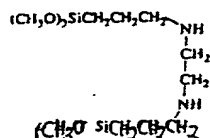
(3-ACRYLOXYPROPYL)TRIMETHOXY-
SILANE, 95%
 $\text{C}_9\text{H}_{18}\text{O}_5\text{Si}$



N-(2-AMINOETHYL)-3-AMINOPROPYLTRI-
METHOXY-SILANE
 $\text{C}_8\text{H}_{22}\text{N}_2\text{O}_3\text{Si}$

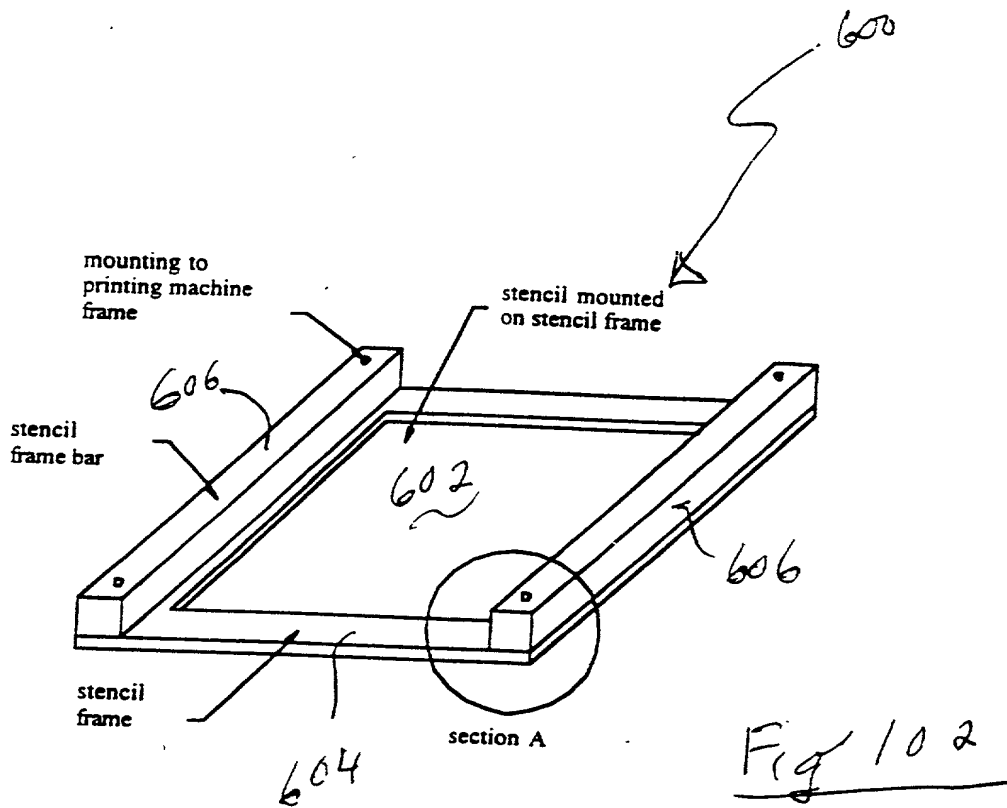


N-(2-AMINOETHYL)-3-AMINOPROPYLMETHYL-
DIMETHOXY-SILANE
 $\text{C}_8\text{H}_{22}\text{N}_2\text{O}_2\text{Si}$



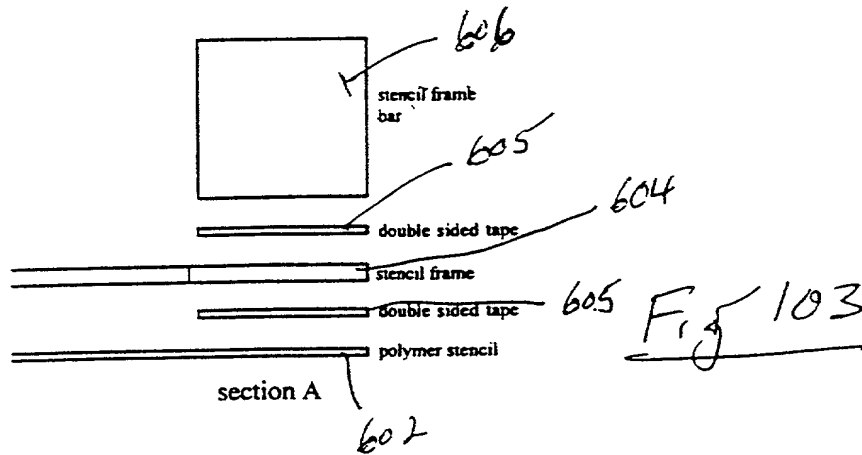
BIS[3-TRIMETHOXY-SILYL]PROPYL]-
ETHYLENEDIAMINE,
 $\text{C}_{14}\text{H}_{36}\text{N}_2\text{O}_6\text{Si}_2$

1006495 020102

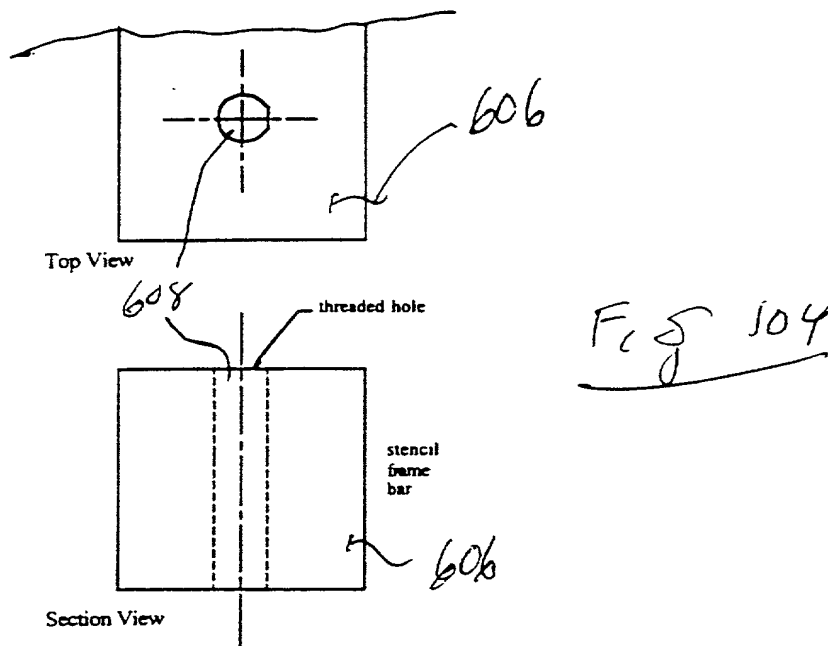


Stencil Frame Layout.

1004456 35733007

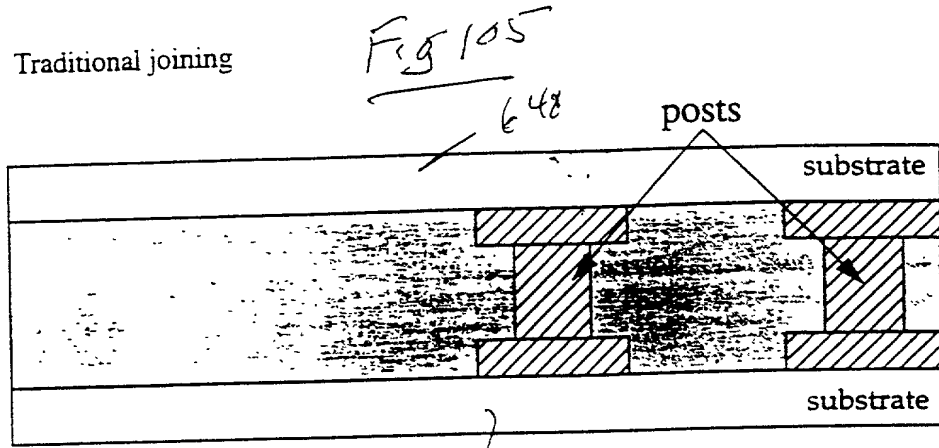


Section View of Stencil Frame Components.

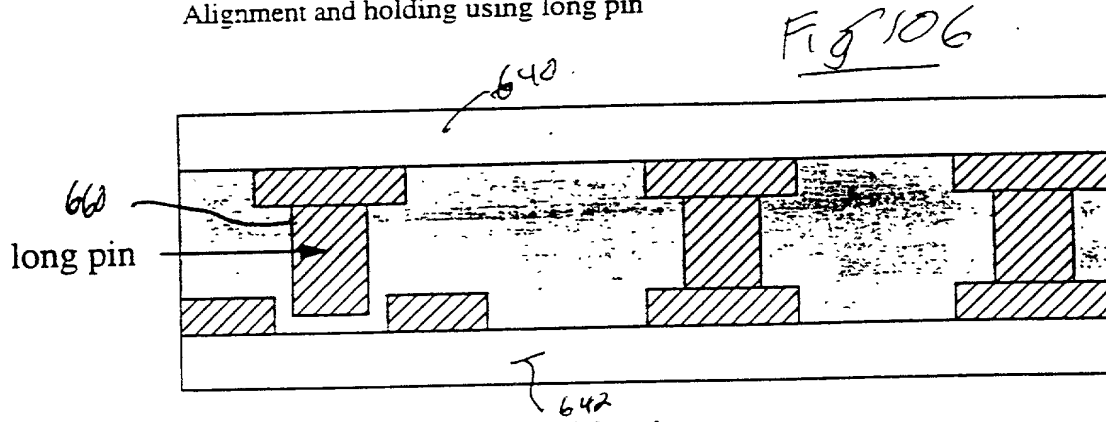


Tapped Hole in Stencil Frame Bar.

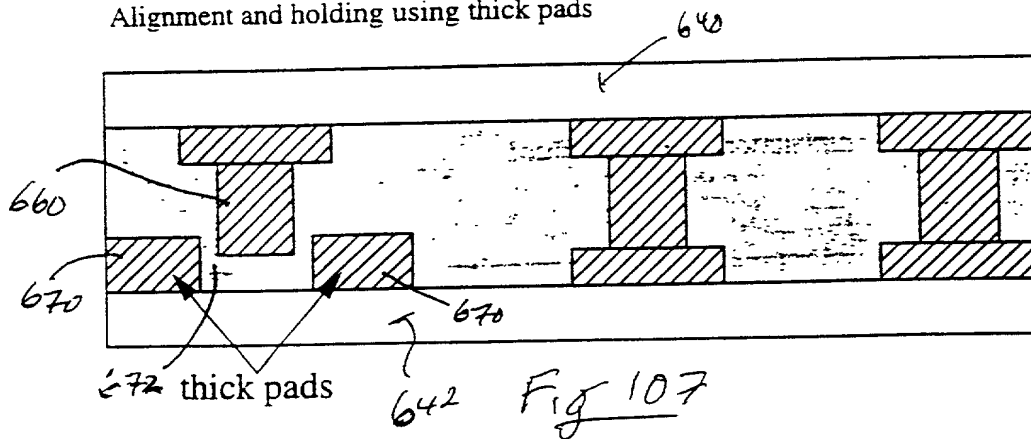
Traditional joining



Alignment and holding using long pin



Alignment and holding using thick pads



Build-up process for long pin

Fig 108

(a)

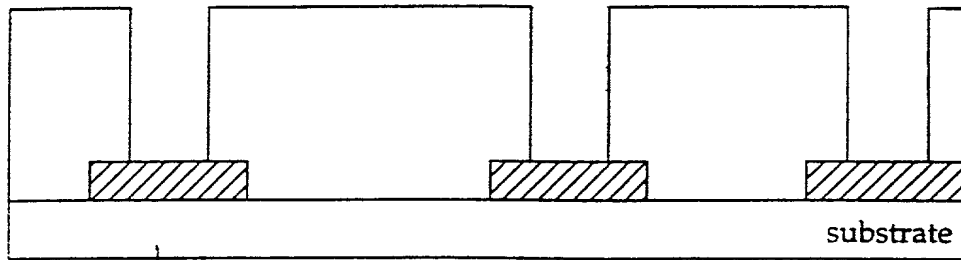
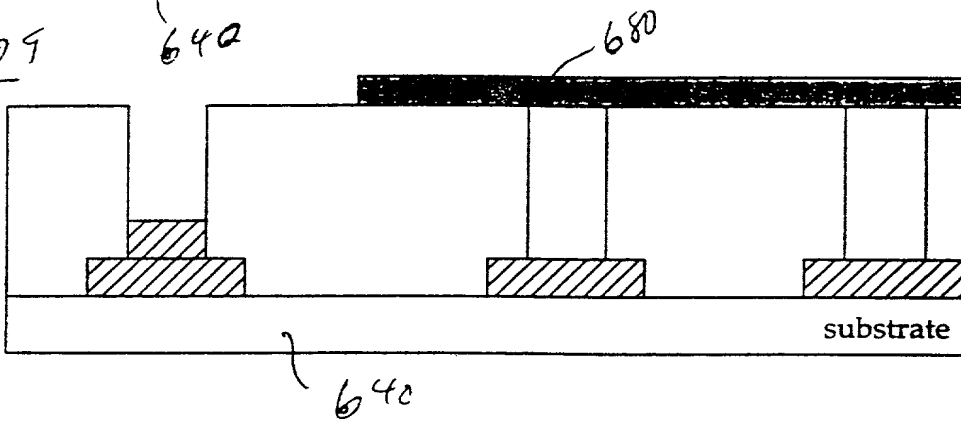


Fig 109

(b)



(c)

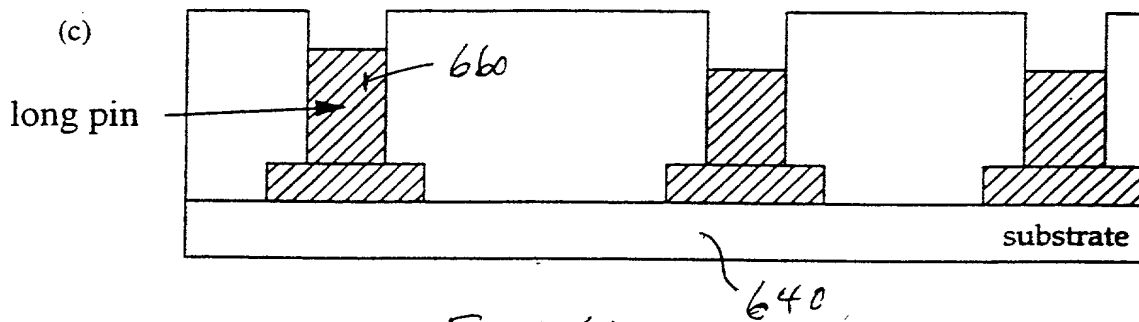


Fig 110

1006496 000100

Fig 111

Another build-up process for long pin

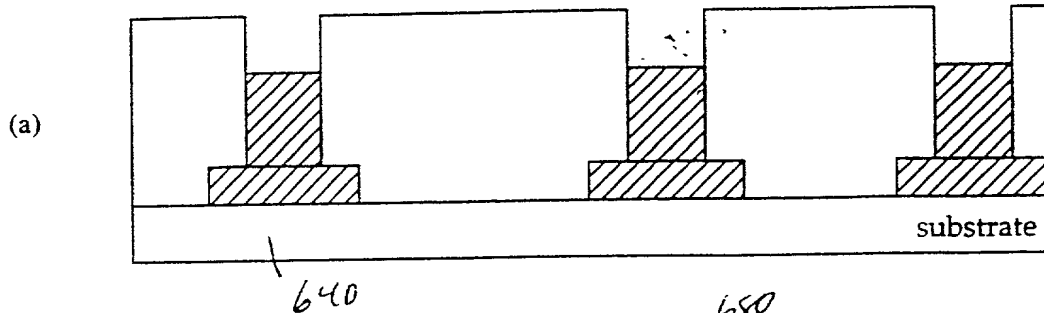


Fig 112

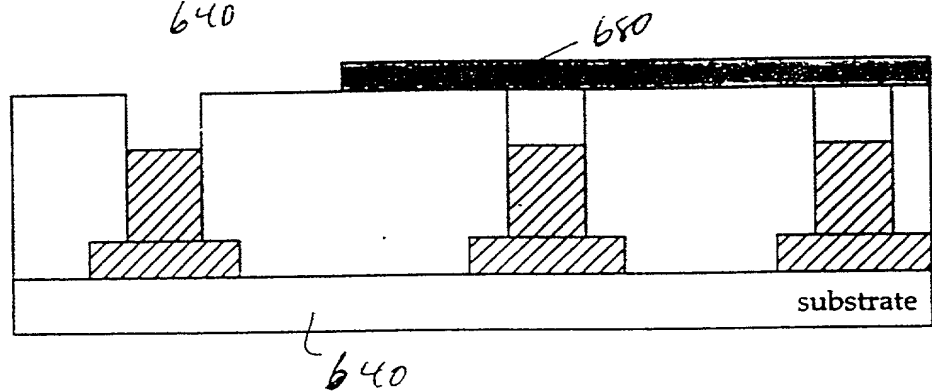
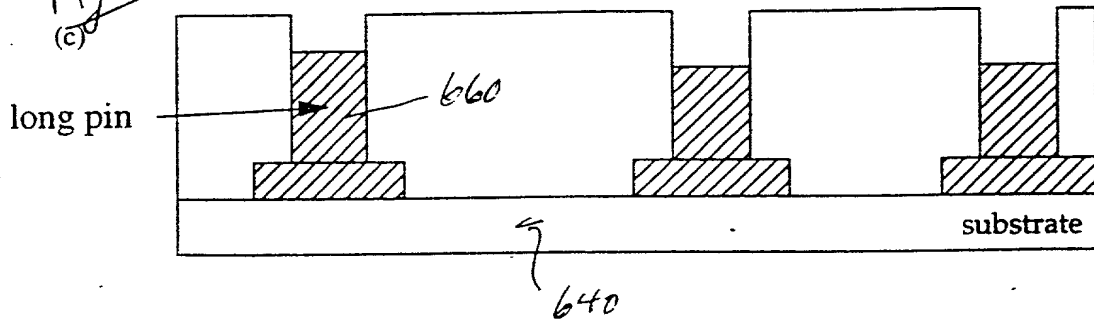
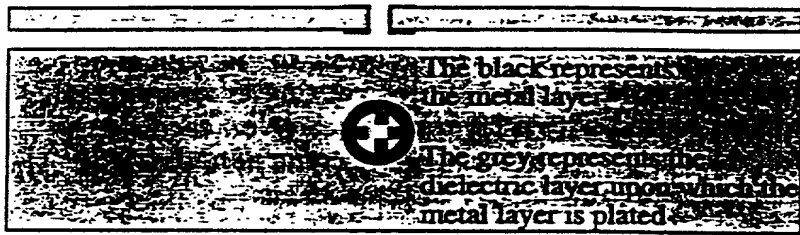
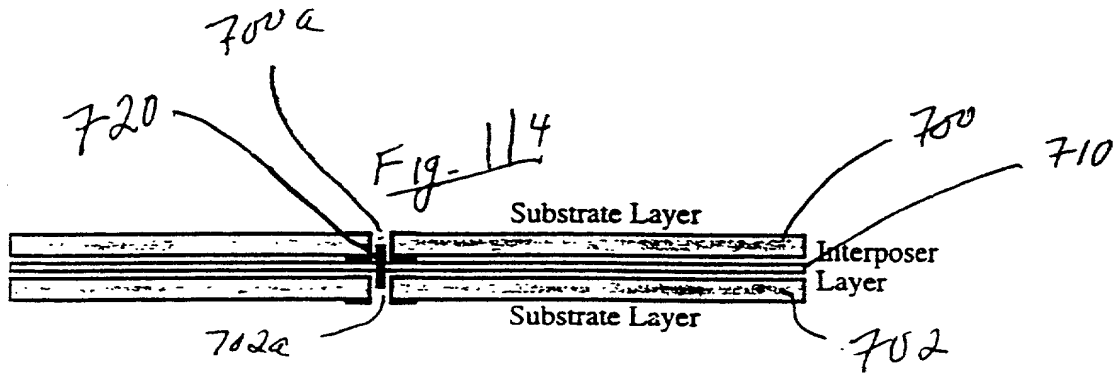


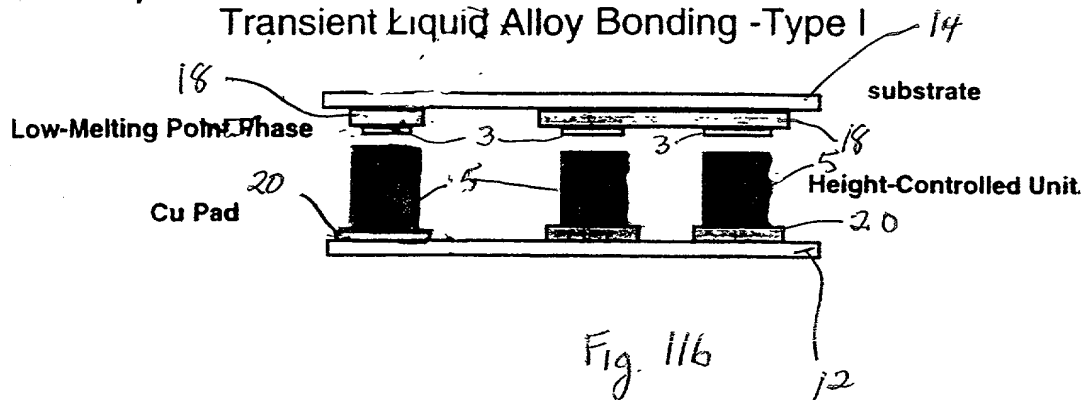
Fig 113





Transient liquid alloy bonding process with separate bonding phases.

Transient Liquid Alloy Bonding - Type I



Transient liquid alloy bonding process with one side bonding phases.

Transient Liquid Alloy Bonding - Type II

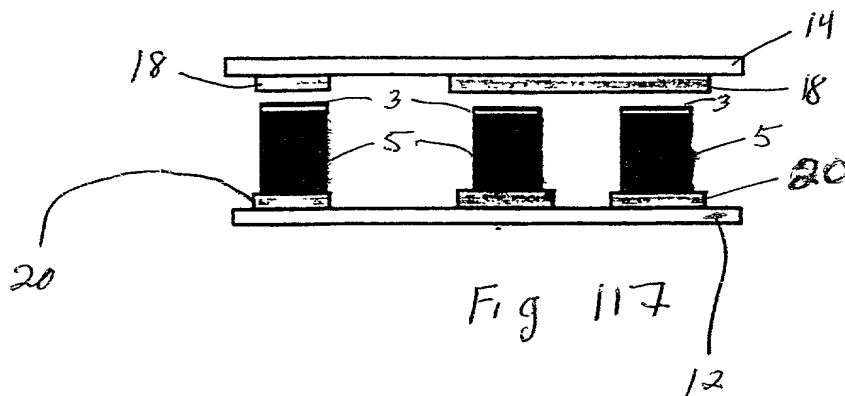


FIG. 118

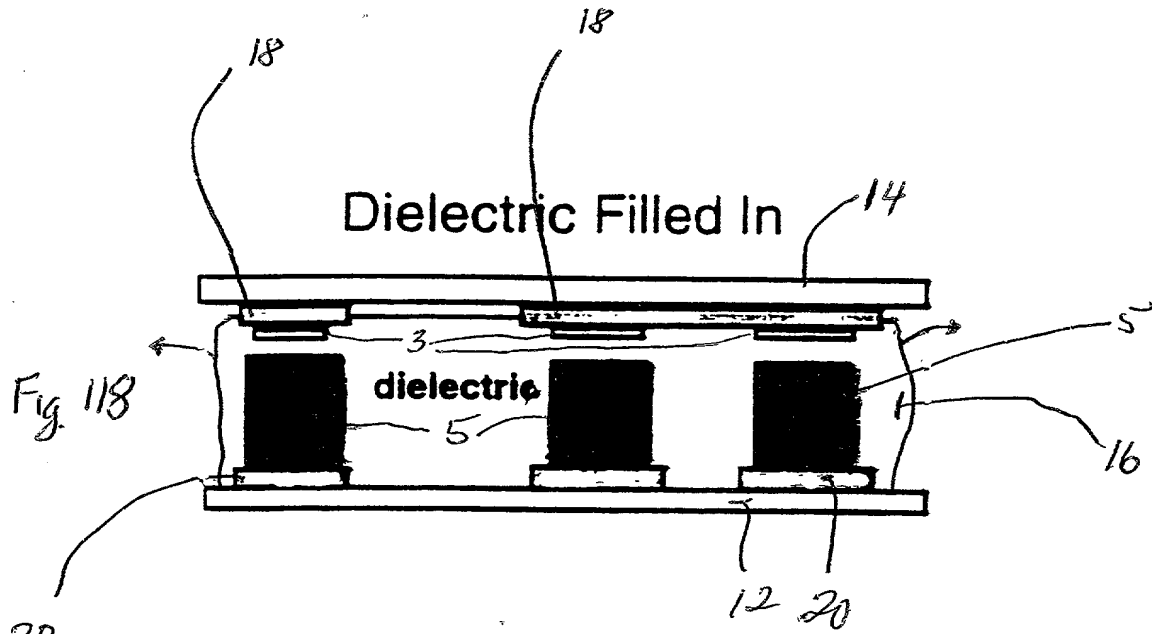


Fig. 119.

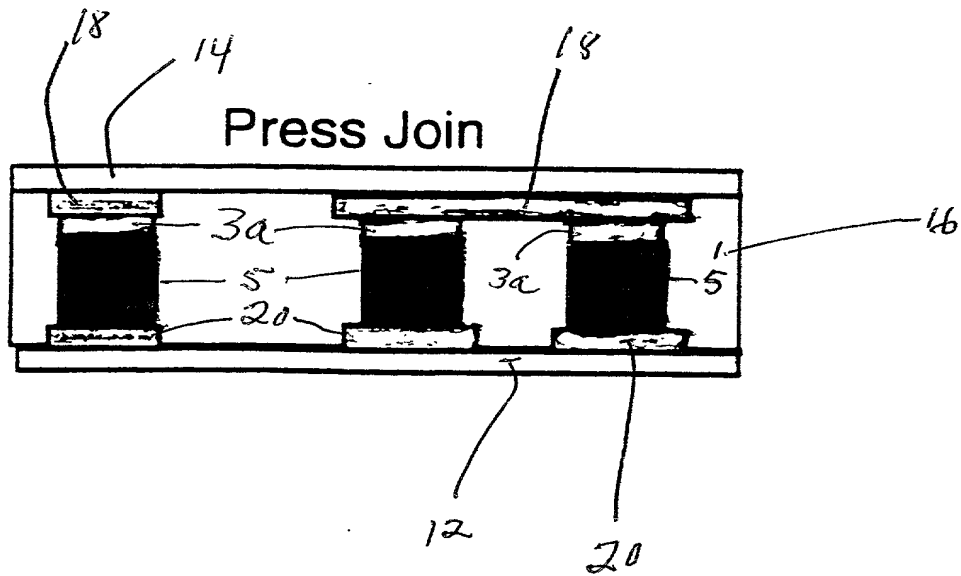


FIG. 120

Press Join with heat

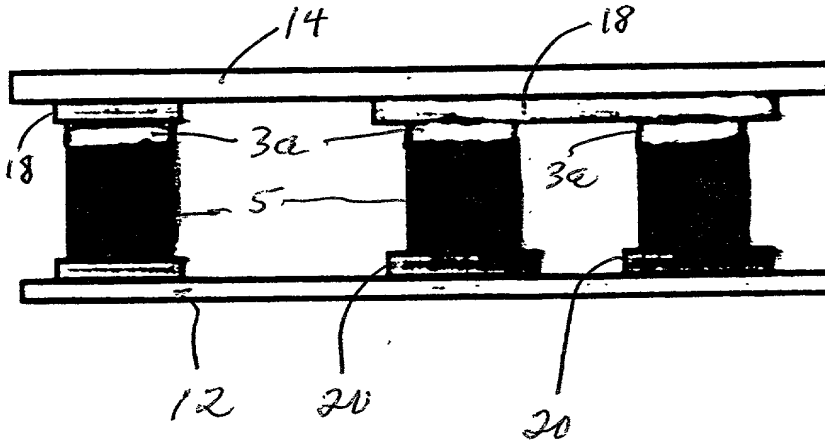


Fig. 120

Dielectric Filled In

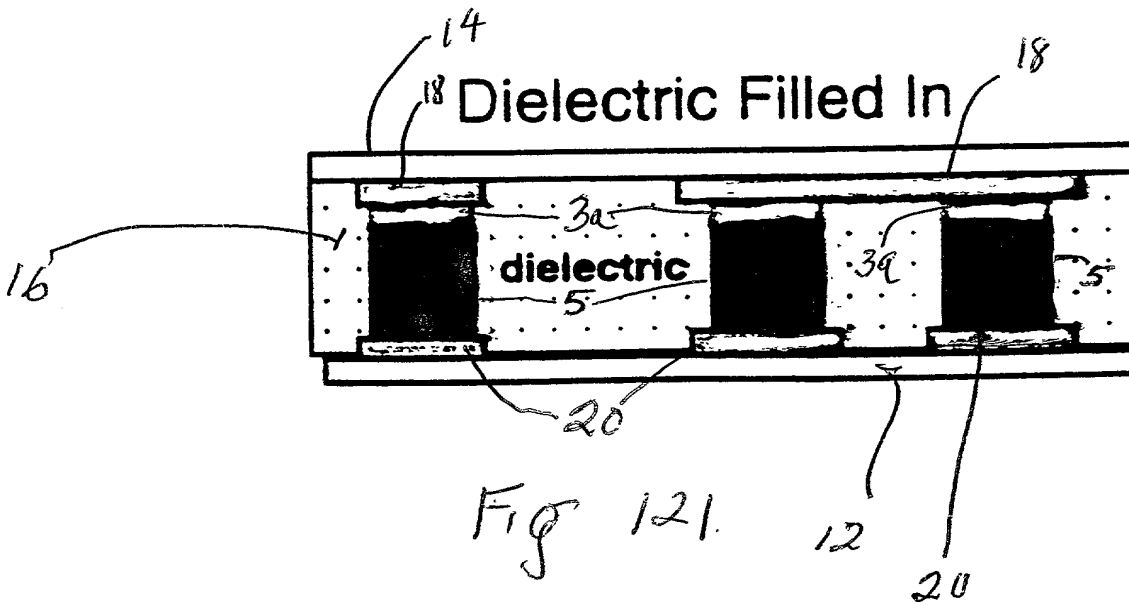


Fig 121.

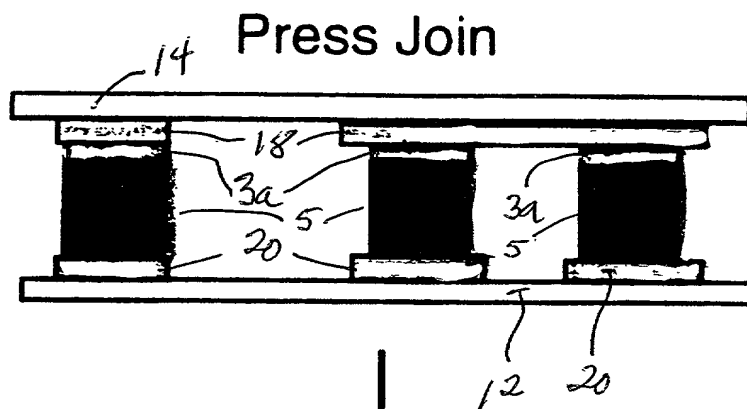


Fig 122.

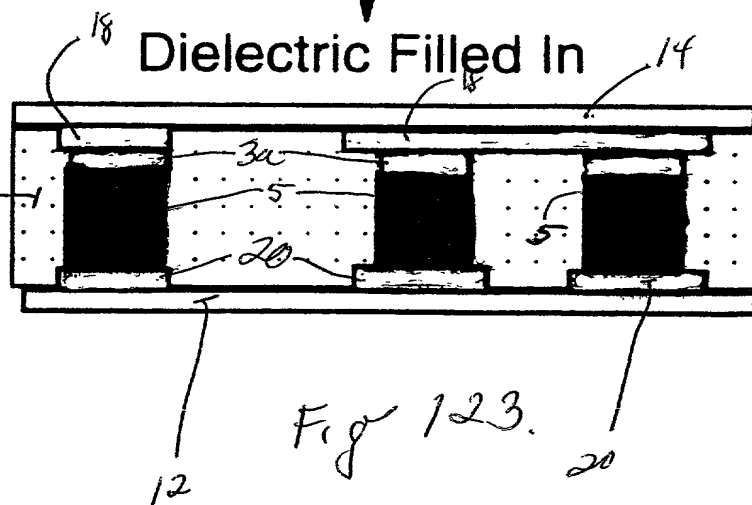


Fig 123.

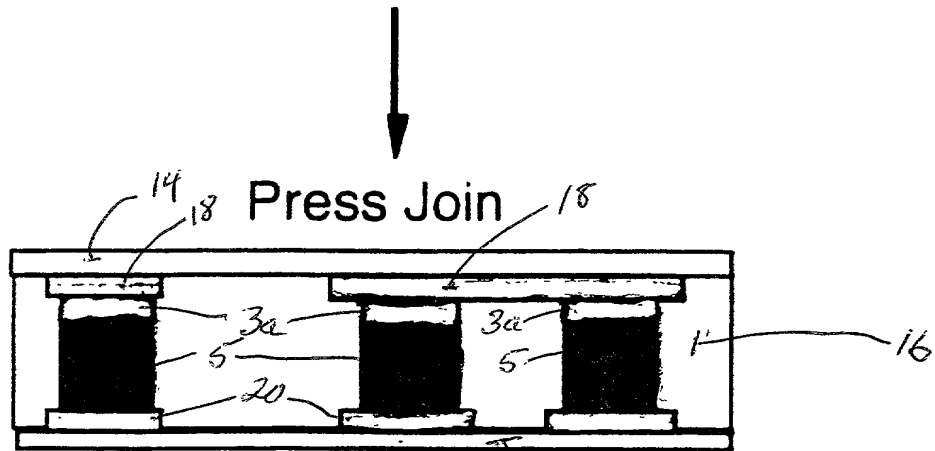
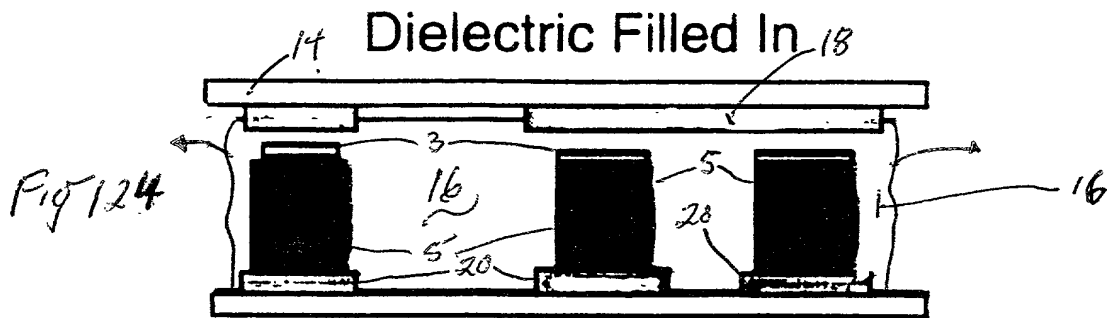


Fig 125

12